ARMY ORDNANCE

VOL. XX, No. 120 MAY-JUNE, 1940

MAY 6 1940

Our Rearmament
Maj. Gen. C. M. Wesson

The Ideal Combat Unit
Brig. Gen. Henry J. Reilly

Optics and Defense
Carl L. Bausch

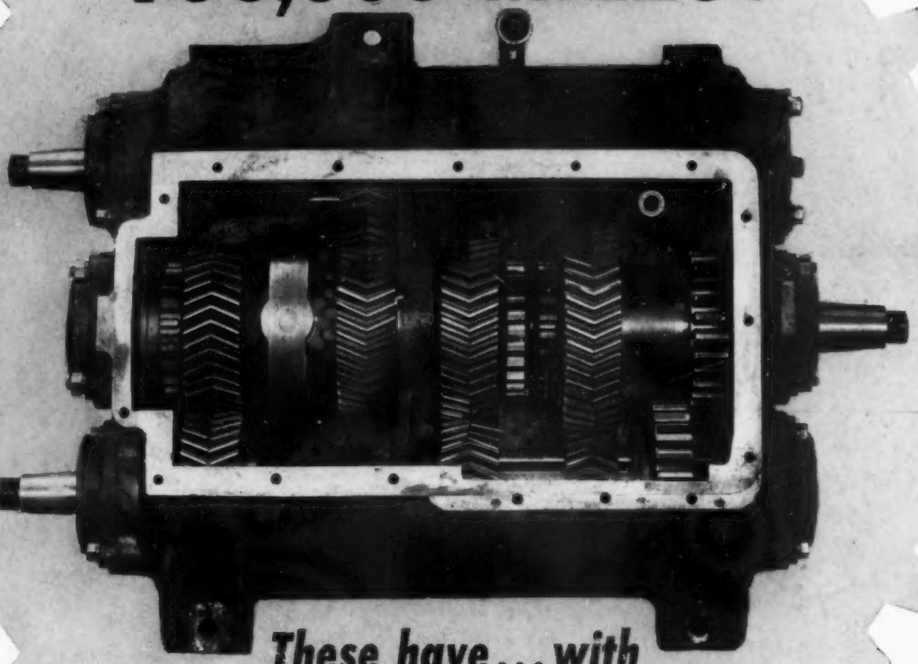
Industry's Manual of Arms
Col. H. K. Rutherford

Military High Explosives
Capt. Carl R. Dutton

Production Studies
An Editorial

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

Do YOUR gears last 750,000 MILES?

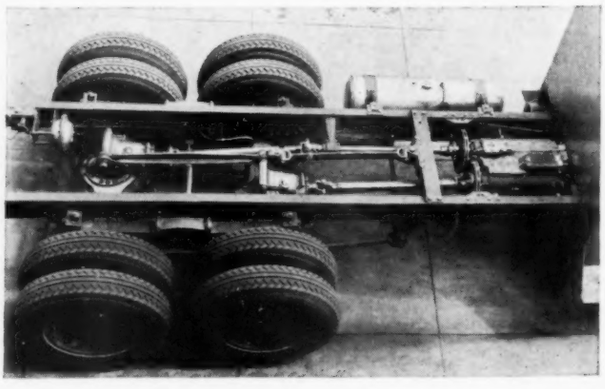


These have... with NICKEL ALLOY STEELS

(ABOVE) Split-drive transmission for dual axles. The 5% Nickel steel gears pictured here have served more than 750,000 miles! Recent inspection shows only slight wear and indicates considerably more mileage before replacements. Here is proof that Nickel alloyed steels are tough and long wearing.

Milk truck schedules must be maintained, despite blizzards off Lake Michigan and midsummer heat waves. This six-wheel tank truck, built by the Hendrickson Motor Truck Co., Chicago, has covered 750,000 miles on schedule with no trouble, only ordinary maintenance, and never a transmission failure. Transmission gears, product of the Foote Gear Works, Chicago, are SAE 2515, a 5% Nickel steel, case hardened.

Picture at right shows chassis details of the Hendrickson dual drive milk truck. Nickel alloyed steels make possible unusual service records and assure uninterrupted operation in normal usage. Your SAE handbook lists Nickel alloyed steels which have proved satisfactory in highly stressed automotive applications.



THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Founded 1920

Pledged to Industrial Preparedness as Our Strongest Guaranty of Peace

Volume XX **MAY-JUNE, 1940** **No. 120**

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Published by the Army Ordnance Association, Suite 806, The Mills Building, Washington, D. C. Managing Editor: Lieut. Col. L. A. Codd, Ord. Res.; Associate Editor: R. E. Lewis, Jr. Authors are responsible for statements and opinions expressed in their articles. Copyright, 1940, by the Army Ordnance Association, Washington, D. C. Permission to republish is reserved.

Issued bimonthly. Single copy 75¢ (by mail). Subscription rate: continental U.S., $4.50 annually; foreign, $5.00, in advance. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D.C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Three weeks' notice before next issue required for change of address.

The Army Ordnance Association

THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guaranty of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency, time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

The Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application on request.)

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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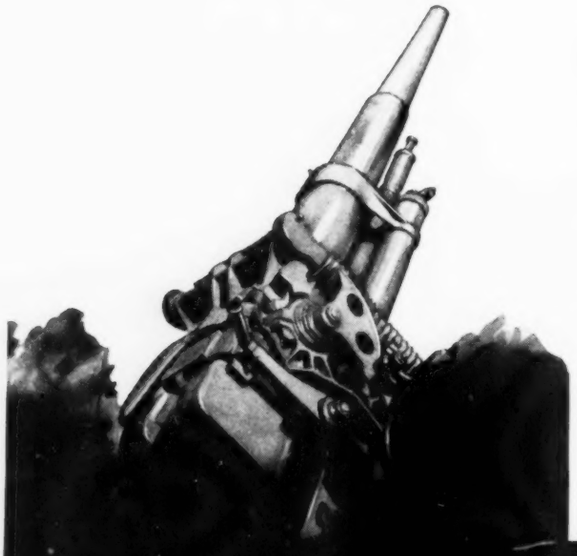

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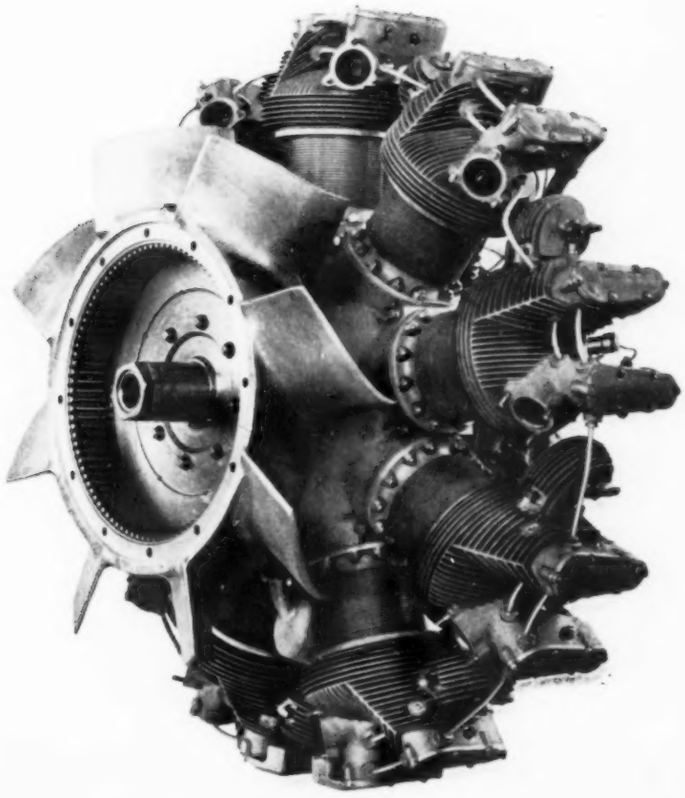

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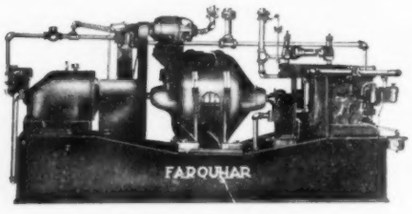

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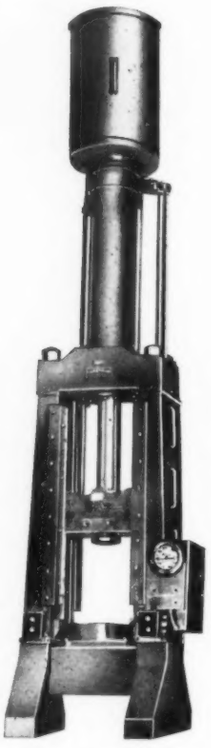

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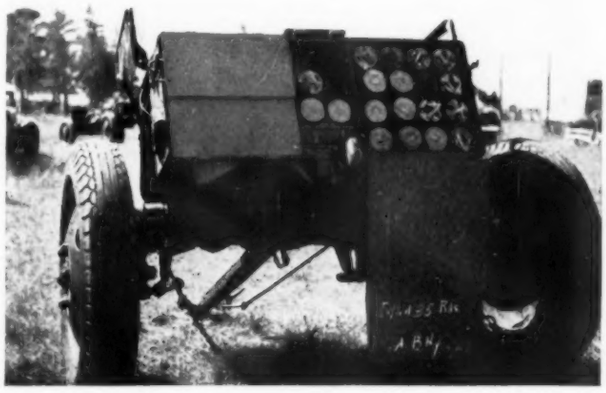

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On Guard

ARMY ORDNANCE

Volume XX MAY-JUNE, 1940 No. 120

Our Rearmament

The Status of the Main Objectives of the Ordnance Program

By Maj. Gen. C. M. Wesson*

BEFORE taking up the 1941 estimates, I feel that the committee would like to have from me a general statement regarding the status of the main objectives of the 1940 program. As regards the important items of new equipment and ammunition, the several 1940 appropriations made available for their manufacture and procurement a total of approximately $134,600,000. Of this amount some $5,600,000 has just become available.

Orders placed with industry and manufacturing arsenals to date aggregate $120,000,000 or about 93 per cent of all the funds appropriated, exclusive of the funds just made available. The remaining seven per cent has been delayed awaiting standardization of new types of equipment. It is hoped that orders for these items may be placed in the near future. The final distribution of the program between the Government arsenals and industry will be as follows: $67,800,000 to the arsenals and $66,800,000 to industry direct.

Since approximately one-half the money value of orders placed with the manufacturing arsenals goes to industry in the form of orders for materials and components for the items made at the arsenals, industry will receive, either directly or indirectly, orders amounting to approximately $99,000,000, or 75 per cent of the funds devoted to new equipment and new ammunition. As of today, industry has received direct orders of approximately $60,000,000 and orders amounting to approximately $25,000,000 for components and materials used in arsenal manufacture—a total of $85,000,000 or 86 per cent of the amount it will eventually receive. In addition to the foregoing, industry will receive for the purchase of machinery some $8,000,000, of which amount orders aggregating approximately 80 per cent already have been placed.

These figures I have mentioned are significant in disclosing industry's share of this program. The arsenals also are doing work for the Navy Department aggregating nearly $16,000,000, and about $5,000,000 of these funds will go to industry for materials and components required by the arsenals for the prosecution of this work.

As to the time required to complete this program, deliveries are just commencing, and with the exception of very few orders the program will be completed about December 1941. The estimated per cent of completion at different periods is as follows: 25 per cent, September 1940; 50 per cent, February 1941; 75 per cent, June 1941; 97 per cent, December 1941; 100 per cent, June 1942.

You will be interested, I am sure, in a list of some of the outstanding orders which have been placed with various industrial firms. This list appears on page 369.

Those orders aggregate approximately $25,000,000. In this program, approximately 782 awards have been made to industry direct for major items, and those awards have gone to approximately 300 different companies located throughout the United States. These figures do not include the number of orders which the arsenals have placed for their components, nor do they give a conception of the number of subcontractors involved in the program. For example, the York Safe & Lock Company, which built the antiaircraft carriages, had seventy subcontractors located from Boston to Chicago.

THIS analysis was presented in connection with the annual estimates before the War Department Subcommittee of the Appropriations Committee of the House of Representatives.

In this statement, the Chief of Ordnance not only presents a program of projects which are necessary if our national-defense obligation is to be met from the standpoint of military armament, but he also renders an account of stewardship for operations authorized by the Congress and entrusted to him for execution. Too frequently in the expenditure of public monies only future projects are emphasized. Here, indeed, current obligations are described and the status of execution is made known.

There is yet another aspect of this statement which will bring encouragement to all students of ordnance in the United States. Current armament production is almost equally divided between private industry and Government arsenals. In this manner the two sources of armament supply in time of national emergency are utilized. The Government arsenals fulfill their greatest function when they provide limited production to sustain at all times the technique of armament making. Private industry, since it must carry the major portion of any military armament load in a national emergency, also must operate in time of peace if its function in time of war is to be met expeditiously.

Hence it is with special approbation that ARMY ORDNANCE *brings to its readers this succinct analysis of our present ordnance program, not only for the objective fact it contains but as well for the encouraging prospect it envisages.*—EDITOR.

*Chief of Ordnance, U. S. Army.

The Chief of Ordnance Announces Two New Weapons

Courtesy of Life Magazine

Here are shown the latest additions to the Army's standard mobile weapons. The new 90-mm. antiaircraft gun, above, is more powerful than the present 3-inch gun which it will augment. The new 105-mm. howitzer, below, will be used as a supporting weapon for the 75-mm. gun. Both types were designed and built by the Ordnance Department, U. S. Army.

Courtesy of Life Magazine

As to the relatively large program for the renovation of war-time ammunition, this is being carried out at the following Ordnance Department depots: Delaware, Charleston, Ogden, Nansemond, and Savanna. Some of these depots are on a 3-shift and others on a 2-shift basis. Ogden is the only depot on a 1-shift basis. Principal items being renovated are shell and shrapnel for the 75-mm. gun; 155-mm. howitzer, and 155-mm. gun shell. This program will be completed in June 1941.

Referring to that part of the program for the overhaul and modernization of some fifty-two different items of equipment so as to condition this matériel for immediate use, this work is proceeding according to schedule at the arsenals and depots and will be completed in June 1941.

New construction of magazines at Delaware and Savanna Depots is proceeding satisfactorily. Contract has been made for the new loading plant at Savanna. The added bomb-loading capacity provided by this plant will enable the bombs in the present large program all to be loaded by the autumn of 1941.

SOME OF THE PRINCIPAL PRODUCTION ORDERS FOR MILITARY ARMAMENT PLACED WITH PRIVATE INDUSTRY

Item	*Name of Contractor*	*Value of Order*
Light tanks	American Car & Foundry Co.	$6,055,251
M1 rifles	Winchester Repeating Arms Co.	8,710,000
8-inch railway mounts	Baldwin Locomotive Works	1,114,454
3-inch antiaircraft mounts	York Safe & Lock Co.	556,000
Scout cars	White Motor Co.	1,649,462
60-mm. mortars	Read Machinery Co.	187,830
Sound locators	Sperry Gyroscope Corp.	1,765,157
Bomb bodies	Bethlehem Steel Co.	2,667,924
37-mm. antiaircraft gun mechanisms	Colt's Patent Fire Arms Manufacturing Co.	1,175,237

THE increase in the funds available for research and development made it possible to strengthen the organization and to accelerate the development of important projects. Many critical items during the past year, after complete tests by the using arms, were approved by the War Department as standard and made available for procurement. Included in the list are such items as the 105-mm. howitzer carriage, several different types of fire-control instruments, and new and improved fuzes. The 90-mm. antiaircraft gun, carriage, and ammunition therefor were given a test by the Coast Artillery which terminated in a highly satisfactory manner. They are to be approved as the standard antiaircraft matériel for future manufacture. In the work of research and development, every opportunity is sought to take advantage of the engineering and technical assistance available through our various technical committees created by the coöperation of our American engineering societies and from various industrial firms with which we are in contact. A large number of projects relating to improved designs and new developments are being carried out by firms well qualified to undertake them.

The arsenals are beginning to reap real benefits as a result of the new machinery provided in 1940 appropriations to commence their rehabilitation. This program, I hope, may be carried on intensively in the fiscal year 1941.

The Ordnance program for the current fiscal year, by far the largest in the peace-time history of the Department, has presented many problems and has not been without its difficulties. The entire organization of the Department has had to be expanded greatly. The Reserve officers that we have been able to place on active duty have been a material help. The problems of ordnance design and production are quite special, and industry in general offers no counterpart; so, in building up an organization, it has been difficult to find, in the professional grades, men of experience in our particular field. In many cases there has been a dearth of the high-grade mechanic. Therefore, the problems of design, development, production, and inspection of equipment have involved comprehensive training in connection with the many technical aspects of these problems. . . .

Now taking up the 1941 estimates which total $73,641,358, of which $25,000,000 is in the form of contract authorization, I would like to make some remarks on several of the objectives sought with these funds. First, there is the important project of critical items of equipment. These estimates provide approximately $21,500,000 toward remedying the shortage in initial equipment for existing organizations, to provide antiaircraft equipment, semiautomatic rifles, mortars, howitzers and ammunition. There is also included an additional $10,000,000 for antiaircraft equipment and semiautomatic rifles beyond the requirements of existing forces. The time required for the production of these critical items makes it highly desirable that their procurement be not delayed.

For building up stocks of ammunition in those categories where the greatest deficiency now exists, $15,542,000 is provided. This amount, however, includes $5,500,000 for the replacement of losses in stocks due to deterioration of World War pyro powder.

A material increase is being requested in funds for procurement planning, chiefly for the procurement of production studies. Under the authority contained in the 1940 appropriation act for the procurement of production studies, a beginning has been made in this important field. And while a small number of production studies are being procured through the medium of educational orders and current production orders, there is a vast amount of work that remains to be done. It is planned with the funds here requested to obtain approximately 420 additional production studies. In my opinion this project, whereby industry becomes more ready to undertake its war-time task and to perform that task in a minimum time, is one that should be continued from year to year, as the work is of paramount importance to national defense. . . . For research and development, $2,673,000 is provided. . . .

These estimates show certain increases in the projects pertaining to ammunition for target practice and training and for maintenance of equipment. These increases result from a small increase in the Army, a large increase in the quantity and value of equipment which will be in the hands of troops, and a very large increase in the contemplated use of this equipment in connection with the proposed greatly increased training period.

*Educational Order Awards for the Fiscal Year 1940**

Ordnance

Item	*Manufacturer*	*Amount*
Aircraft parachute flares	Kilgore Manufacturing Co., Tippecanoe City, Ohio	$ 13,331.50
Do	National Fireworks, Inc., Boston, Mass	13,431.00
Fuze, bomb (three types)	Grayson Heat Control, Ltd., Lynwood, Calif	98,092.43
Do	Chrysler Corporation, Detroit, Mich	97,079.03
Do	Corbin Screw Corporation, New Britain, Conn	29,340.60
Howitzer, 75-mm. pack	C. H. Cowdrey Machine Works, Fitchburg, Mass	174,208.50
Forging, 81-mm. shell	Dresser Manufacturing Co., Bradford, Pa	3,993.30
Signals, ground, parachute (2 types)	Essex Specialty Co., Inc., Berkley Heights, N. J	6,791.93
Do	Unexcelled Manufacturing Co., Reading, Ohio	8,241.25
Do	Triumph Explosives, Inc., Elkton, Md	5,660.00
Do	M. Backes' Sons, Inc., Wallingford, Conn	8,056.10
Bomb, demolition, 500-pound (metal components)	Consolidated Steel Corporation, Los Angeles, Calif	109,626.00
Bomb, demolition, 1000-pound (metal components)	American Car & Foundry Co., Berwick, Pa	81,167.00
Booster (metal components)	Electric Household Utilities Corporation, Chicago, Ill	42,656.67
Do	National Pneumatic Co., Rahway, N. J	62,745.63
Do	Wright Machine Co., Worcester, Mass	74,238.00
Do	Federal Screw Works, Detroit, Mich	59,795.28
Do	Sunbeam Electric Manufacturing Co., Evansville, Ind	77,799.28
Do	Warren Webster & Co., Camden, N. J	34,551.37
Fuze, point-detonating (metal components)	National Cash Register Co., Dayton, Ohio	70,132.99
Do	Fulton Sylphon Co., Knoxville, Tenn	101,991.00
Do	Federal Screw Works, Detroit, Mich	72,040.85
Do	Philadelphia Storage Battery Co., Philadelphia, Pa	133,485.64
Range quadrant, light artillery	Cummings Machine Works, Boston, Mass	51,587.50
Pistol, automatic, cal. .45	Harrington & Richardson Arms Co., Worcester, Mass	192,497.50
Do	Singer Manufacturing Co., Elizabeth, N. J	278,875.67
Machining, 75-mm. shell	Armstrong Cork Co., Lancaster, Pa	85,165.11
Do	J. B. Beaird Corporation, Shreveport, La	108,770.35
Do	Continental Gin Co., Birmingham, Ala	72,521.40
Do	Chrysler Corporation, Detroit, Mich	110,616.50
Do	Darling Valve & Manufacturing Co., Williamsport, Pa	58,902.63
Do	General Railway Signal Co., Rochester, N. Y	102,560.28
Do	Kingston Products Corporation, Kokomo, Ind	44,372.70
Do	The Murray Co., Atlanta, Ga	91,206.35
Do	New York Air Brake Co., New York, N. Y	79,552.31
Do	Robbins & Myers, Inc., Springfield, Ohio	85,170.00
Do	Stockham Pipe Fittings Co., Birmingham, Ala	69,957.62
Do	U. S. Machine Corporation, Lebanon, Ind	38,055.83
Do	Wheland Co., Chattanooga, Tenn	66,758.67
Do	Chevrolet Motor Division, G. M. C., Detroit, Mich	100,850.00
Forging, 75-mm. shell	Chrysler Corporation, Detroit, Mich	67,732.00
Do	Pressed Steel Car Co., Pittsburgh, Pa	119,832.00
Do	Tennessee Coal, Iron & Railroad Co., Birmingham, Ala	130,350.50
Do	Pittsburgh Forgings Co., Coraopolis, Pa	36,364.88
Do	Chevrolet Motor Division, G. M. C., Detroit, Mich	36,127.20
Forging, 155-mm. shell	Colorado Fuel & Iron Co., Denver, Colo	251,674.25
Do	Taylor-Wharton Iron & Steel Co., Easton, Pa	209,217.25
Machining, 155-mm. shell (howitzer and gun)	The Key Co., East St. Louis, Ill	164,205.30
Do	Minneapolis-Moline Power Implement Co., Minneapolis, Minn	139,628.60
Do	Omaha Steel Works, Omaha, Nebr	161,658.00
Centrifugal castings	The Duraloy Co., Scottdale, Pa	148,920.00
Telescope, antitank gun	Eastman Kodak Co., Rochester, N. Y	34,566.01
Cartridge case, 75-mm. gun	Chrysler Corporation, Detroit, Mich	154,082.40
Machining, 81-mm. shell	W. C. Norris Manufacturer, Inc., Tulsa, Okla	76,689.59
Telescope, mount (two types)	Precision Manufacturing Co., Philadelphia, Pa	71,220.00
Do	Builders Iron Foundry, Providence, R. I	105,509.94
Fuze, time and superquick	Scovill Manufacturing Co., Waterbury, Conn	153,152.00
Telescope, panoramic	Mergenthaler Linotype Co., Brooklyn, N. Y	99,245.03

Chemical Warfare Service

Gas masks	Firestone Tire & Rubber Co., Fall River, Mass	$328,329.00
Do	Johnson & Johnson, Chicago, Ill	347,714.00
Gas mask carrier	Goodyear Tire & Rubber Co., Akron, Ohio	88,167.00
Noncoconut charcoal	Carlisle Lumber Co., Onalaska, Wash	283,990.00
Whetlerite	Carlisle Lumber Co., Onalaska, Wash	61,627.50

Signal Corps

Telephone, field	Kellogg Switchboard & Supply Co., Chicago, Ill	$ 36,938.27
Do	Holtzer-Cabot Electric Co., Boston, Mass	43,482.63
Do	Stromberg-Carlson Telephone Manufacturing Co., Rochester, N. Y	48,984.88

*Compiled as of March 15, 1940.

Industry's Manual of Arms

A Progress Report on the Educational Orders Program

By Col. H. K. Rutherford*

SATISFACTORY progress is being made in the administration of the educational-orders program. At this writing, the basic statistics regarding the authorized program for the fiscal year 1940 are: 1. Awards for 60 per cent of the items on the educational-orders list have been made. 2. These orders involve 50 per cent of the money ($14,250,000) appropriated. 3. They relate to 70 per cent of the plants in which this program of educational orders will be executed. In a word, American industry again is displaying that genius for coöperative and convincing results—a reputation long known to the Army and Navy of the United States and proportionately appreciated by those agencies of our national defense.

It is at the solicitation of the editor of ARMY ORDNANCE that the author presents this article as a progress report on educational orders. By way of background, it will be remembered that there was published in the pages of this journal (November-December 1939, Vol. XX, No. 117) a comprehensive discussion, both historical and current, of the educational-orders philosophy, its development through the years, its authorization of law, and the plans and policies approved by War Department and civilian boards for a satisfactory method of operation. The Army Ordnance Association, especially through this journal, has been a prime mover in the educational-orders philosophy. Naturally enough, with the acceptance of the doctrine, its authorization of law, and the appropriations by Congress making possible a long-time educational-orders program, it is appropriate that readers of ARMY ORDNANCE be kept currently informed of the workaday progress which is being made.

As already indicated, that progress is most satisfactory. It is my purpose to elaborate on what has been accomplished thus far and to announce the names of the companies now engaged in educational orders and the items on which they are working. Later on, it is to be hoped that the full program, together with the lessons learned both by industry and Government, will be the subject of many fruitful analyses in these pages.

First let me describe the time cycle of the current program. For the fiscal year 1940 (*i.e.*, the year ending June 30, 1940) the Congress made available $14,250,000 for educational orders. In the preceding year (fiscal, 1939) it had made available $2,000,000 by transfer from other appropriations. The 1939 program resulted in six educational orders placed for the following items and with the companies named: gas masks, Goodyear Tire & Rubber Company, Akron, Ohio; the new semiautomatic shoulder rifle, known as U. S. rifle caliber .30 M1, Winchester Repeating Arms Company, New Haven, Conn.; antiaircraft searchlights, the General Electric Company, Schenectady, N. Y.; the recoil mechanism of the antiaircraft gun mount, R. Hoe & Company, New York, N. Y.; machining 75-mm. shell, the S. A. Woods Machine Company, Boston, Mass.; forging 75-mm. shell, the American Forge Company, Chicago, Ill. At this writing, the orders placed under the 1939 program are not yet completed. Those for gas masks, shell forgings, and recoil mechanisms are nearing completion. The remainder are expected to be completed late in 1940, with the exception of the semiautomatic rifle contract which will be completed in 1941.

BUT to return to the program for the current year. The same procedure for administering the earlier program was followed for the present larger one. Lists of bidders were prepared from the companies holding war-time allocations for the items of equipment concerned. Specifications, contracts, necessary advertising, inspection, acceptance, and payment were handled by the supply arm or service responsible for the equipment concerned. The provisions of law, of course, were the same, as follows:

In accordance with the act of Congress approved June 16, 1938 (52 Stat. 707) as amended by section 13 of the act approved April 3, 1939 (Public No. 18, 76th Congress, 1st session) bids were received only from the firms selected by the Secretary of War and which had been specifically invited to bid. Any other manufacturer who wished to bid on educational orders was required to qualify under the basic requirement as to competence and financial stability, having the general type of equipment which might be adapted to the manufacture of the item concerned together with a willingness to augment his existing facilities by the purchase and installation of such additional items as might be necessary to produce the article on a quantity basis. In addition, the plant must have been large enough to undertake the proposed *war* order (not educational order) with a minimum of expansion. The concern had to be a manufacturing plant, not merely an assembly plant. A few additional firms were added to the initial list of bidders after its preparation.

The number of firms invited to bid on items varied from a minimum of three to a maximum of sixty-one. Actually, the number of bidders was relatively small, varying from none in a few instances to nineteen in one case. Where no bids were received, it was necessary to solicit bids on a reissue of the proposal.

The act approved June 16, 1938 provided specifically that "in the determination of which of the solicited bidders is to be awarded any contract, the Secretary [of War] shall have regard solely to the selection of such classes of special munitions and of such bidders as will, in his judgment, under all the circumstances, best serve the interest of the United States and best promote the interest of national defense." Though not required by law, the policy was adopted of awarding orders to the lowest bidder submitting an acceptable bid. Awards to date have been made to the lowest eligible bidders, except in the very few cases where the circumstances were such that it was clearly to the best interests of the Government to accept other than the low bid. In a number of cases the bids submitted were not responsive to the terms of the proposal and therefore were not acceptable.

*Director, Planning Branch, Office of the Assistant Secretary of War. Colonel, Ordnance Department, U. S. Army.

The same act quoted above required "that no more than one such educational order for the manufacture of the same or substantially the same article of special munitions, shall be given to the same person, firm, or corporation within any period of three successive years." A number of companies submitted bids on two similar items but were awarded an order on only one item. Those companies were not eligible for a second order. Upon investigation it was found that some bidders either had recently manufactured similar items for the Government or else were currently manufacturing items of a similar nature. They were, therefore, not considered eligible for an educational order.

It is particularly pertinent to the purpose of the educational order that the equipment owned by the manufacturing plant plus the equipment to be purchased for the Government on the educational order must be adequate to produce the item. It must be appreciated that in preparing a bid for an educational order, it is necessary to break down the successive steps required in the manufacture of the article in order to cover fully all the manufacturing equipment needed. That in itself constitutes a preliminary production study.

A NUMBER of items on the educational-orders program, particularly ammunition and components of ammunition, are required in very considerable quantities in war. These requirements are such that many sources of supply are necessary. It will be noted from the accompanying table that fourteen orders were placed for machining 75-mm. shell, one of the most important components of ammunition for divisional artillery, of which war requirements are great. Six orders were placed for boosters (metal components) which are required in the same quantities as the shell. As was to be expected, the amount of equipment on hand in plants submitting bids for the same item varied considerably. As a consequence, the amount of equipment necessary to be purchased was greater for some plants, and the cost of the educational order for the same item in different plants varied accordingly.

While educational orders had long been sought as a most important factor in our program of national defense, actual experience in the policy of such orders had been limited to the six placed under the 1939 program. Because of the importance of the program, great care was taken in carrying out the various steps of the adopted administrative procedure. The preliminary work for the current schedule involved the careful preparation of the lists of bidders for the larger program of some fifty-six items. It was necessary to review the form of proposals in the light of the brief experience of the previous year. However, most of the preliminary work was completed and approved by early October, and all by November, 1939.

Because of their unique character, in that much more information is required than in bids on straight supply orders, sixty days was the usual period allowed between the issue of the proposal and the opening of bids. It was necessary, in some cases of particularly complicated items of equipment, to extend the time of opening as much as thirty days. Consequently, the majority of the bids for the 1940 program of educational orders were not opened until December 1939 and January 1940. Some were opened as late as April 1940.

On page 370 is published a tabulation showing the educational orders which have been awarded under the program for the fiscal year 1940, as of March 15th. The data here shown present a fair picture of what has been done thus far in the actual award of orders. After the entire program for this year and the next has been placed with industry, it will be possible to evaluate many of the practices which are now only theories. For example, production analyses will depend upon actual completion of the work in hand. A majority of the orders under the present program will require as much as twelve months from the placing of the contract to completion. In general terms, the orders placed during the current fiscal year will not be completed until well into 1941 and some at a later date. A preliminary study, based on the few orders which have been longest in process, indicates that in the event of a national emergency the experience gained often will permit a reduction of four or more months in reaching quantity production in the particular plants involved.

The contracts actually placed are the result of 705 invitations issued covering 32 items of military equipment. At this writing, 67 educational orders have been awarded from funds made available for the fiscal year 1940. But this by no means represents a completion of the broader program which the Congress has authorized. The act approved April 3, 1939 authorized a total of $34,500,000 to be available during the fiscal years 1939, 1940, and 1941, and a further authorization in the sum of $2,000,000 during each of the four fiscal years succeeding the fiscal year 1941. Of this authorization, $16,250,000 was appropriated for the fiscal years 1939 and 1940. It is proposed to use additional funds appropriated for the fiscal year 1941 in an extension of the educational-orders program for the same items to additional plants and to place orders for other critical items in other plants.

PRESENT programs are concerned with 56 of the most critical items to be procured. But there are 1,200 items and processes of manufacture in the group which will present procurement problems in time of war. The importance of some of these manufacturing processes varies in degree. Many are similar to those used in commercial manufacture. At least one-half, however, are of a distinctly noncommercial nature. They embrace items of equipment which are not procured in quantity in time of peace and yet are the very ones with which industry must be familiar if our requirements in war are to be met. Some 2,000 of the 10,000 plants which have been surveyed would be involved, as prime contractors, in war production of these 600 items of a noncommercial nature.

Thus it will be seen that what has been done to date is of vital importance. From the standpoint of the War Department, the progress that has been made is indicative that the importance of educational orders is thoroughly realized by our military and civilian components and that the initial steps, while somewhat hesitant, have been taken with a firm purpose. It should not be necessary to elaborate here on the processes which have led up to educational orders in reality. Rather it is the hope of those who are administering the program in the War Department, both in the Office of the Assistant Secretary of War and in the several supply arms and services, that from this inadequate progress report two heartening conclusions will be drawn. The first of these is that educational orders are decidedly in actual operation. The second, and far more important conclusion, is that already they have provided a most valuable education both to teacher and to student.

Wings For The Army

THE present and recent European conflicts have thrown into bold relief the potentialities of the airplane as a major weapon in modern warfare and at the same time have brought home sharply to the people of the United States the inadequacies of their own air force in number and types of airplanes. It was to remedy these inadequacies that the Air Expansion Program—a vital phase of our national rearmament—was adopted a year ago when the United States Congress appropriated $300,000,000 for this purpose.

This program aims to increase the air force of the United States Army 2½ times in 2½ years. Within this period 3,300 airplanes are to be produced, bringing the Army's total air strength to 5,500 by June 30, 1941. This is a gigantic task for the aircraft industry of the United States, but so successfully is it being met that production schedules have been maintained during the first twelve months of the program. And this despite the fact that the best in performance and quality has been demanded as well as a maximum service life for the airplanes—which means anticipating, as far as possible, the characteristics of the airplane of tomorrow.

The Air Expansion Program likewise requires that the number of officers on duty with the Air Corps be increased from 1,600 to 4,600—an increase of nearly 300 per cent. The enlisted personnel of the Air Corps will be increased from 18,000 to 45,000. This enormous expansion necessitates the construction of quarters, barracks, hangars, machine shops, and other facilities at a cost of $150,000,000. Many of the old stations are being enlarged and new air bases are being built in New England, Florida, Puerto Rico, Panama, and Alaska. The great influx of new men has overtaxed the Army's training facilities so that civilian aviation schools have been called upon to train a thousand Army mechanics. By June 1941, the Air Corps Technical Schools will have turned out nearly ten thousand enlisted specialists.

The airplanes which are beginning to come from the manufacturers in an ever-increasing stream will be the best that United States military engineers and the industry can produce and will embody many of the new features shown to be essential by military operations abroad. Most of the current standard types of aircraft employed by the U. S. Army Air Corps are illustrated on the following pages. Several innovations will be noted: The interceptor-pursuit ship, with rapid take-off and very fast climb, has been developed as an answer to the high-speed bomber. Its purpose is to intercept attacking hostile aircraft before they reach their targets. The attack airplane has been replaced by the more powerful and more effective attack bomber which carries light bombs in addition to machine guns. Liquid-cooled engines, which permit greater streamlining, are again coming to the fore, and the automatic cannon is replacing the machine gun as the principal aircraft weapon. More speed and greater fire power are the watchwords. (All illustrations shown on this and the following seven pages are from official photographs of the United States Army Air Corps.)

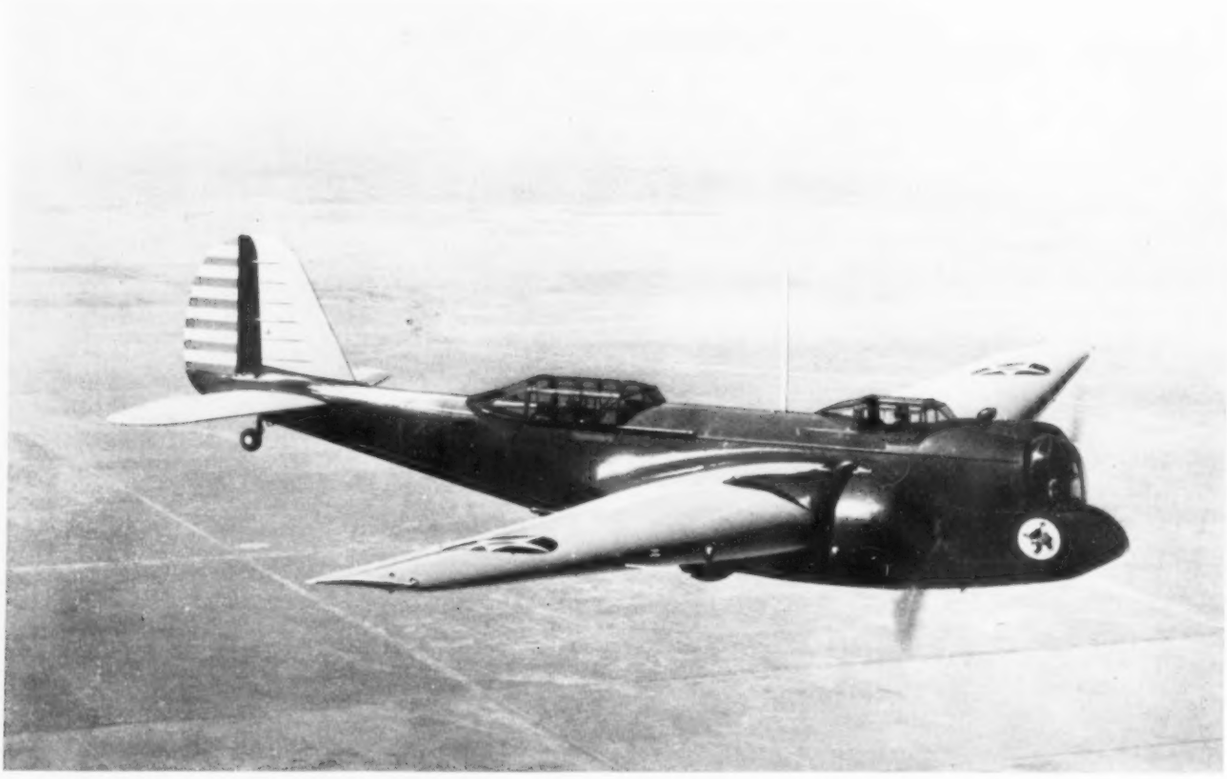
Great Speed and Maneuverability Mark the New Pursuits

The Curtiss P-36A pursuit airplane, above, is an all-metal ship powered with a Pratt & Whitney 14-cylinder, 2-row radial air-cooled engine developing 1,100 h.p., with a speed of over 300 m.p.h. The Lockheed XP-38 interceptor-pursuit, below, powered by two Allison V-12, liquid-cooled engines of 1,000 h.p. each, has a speed of about 400 m.p.h.

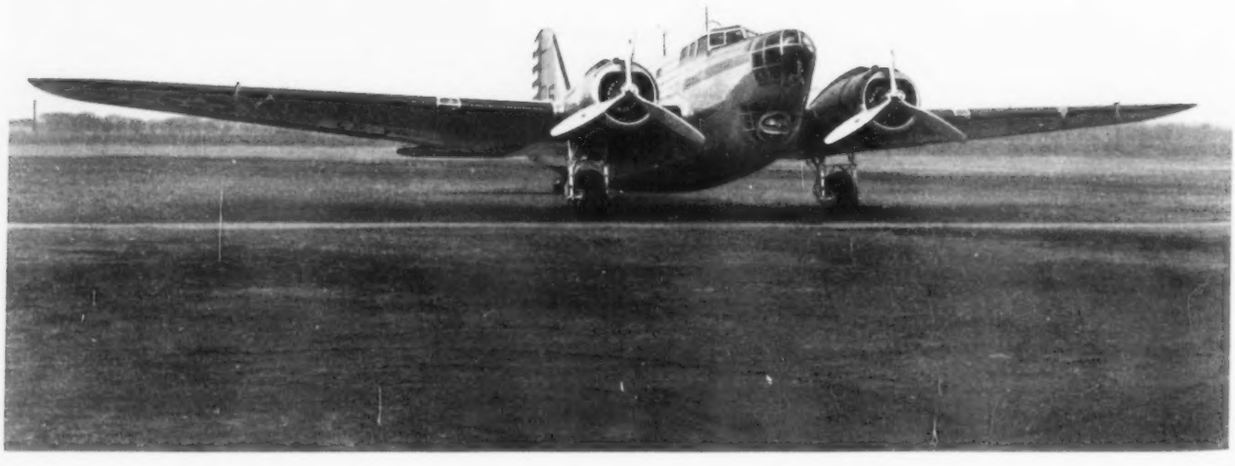
Liquid-cooled Engines Permit Smoother Streamlining

The Curtiss P-40, above, the Army's latest standard pursuit ship, is an internally braced monoplane of all-steel construction, except the control surfaces. Powered with an Allison V-12 liquid-cooled 1,000 h.p. engine, it has a speed of over 300 m.p.h. The Bell XP-39 interceptor-pursuit, below, is powered with the same type engine. Note tricycle landing gear.

The Modern Bomber Has Increased Range and Ceiling



The Martin B-12 bombardment airplane, above, has been a standard-type Army bomber for some years. The Douglas B-18A medium bomber, below, is one of the latest bombardment ships of its class. Note the glass-sheathed nose housing the bombardier and the glass-inclosed rotatable gun mount directly underneath. A retractable glass turret houses a rear gun.



Greater Power Means More Bombs and Heavier Armament

The Boeing B-17 "Flying Fortress" heavy bomber is shown above. Characteristics: 22-ton, all-metal, low-wing monoplane; 4 Wright Cyclone engines; speed, over 250 m.p.h.; 5 machine guns; 10,080 pounds of bombs and ammunition; crew, 7-9 men; range, 3,000 miles. The Douglas B-23 medium bomber, recently developed, is illustrated below.

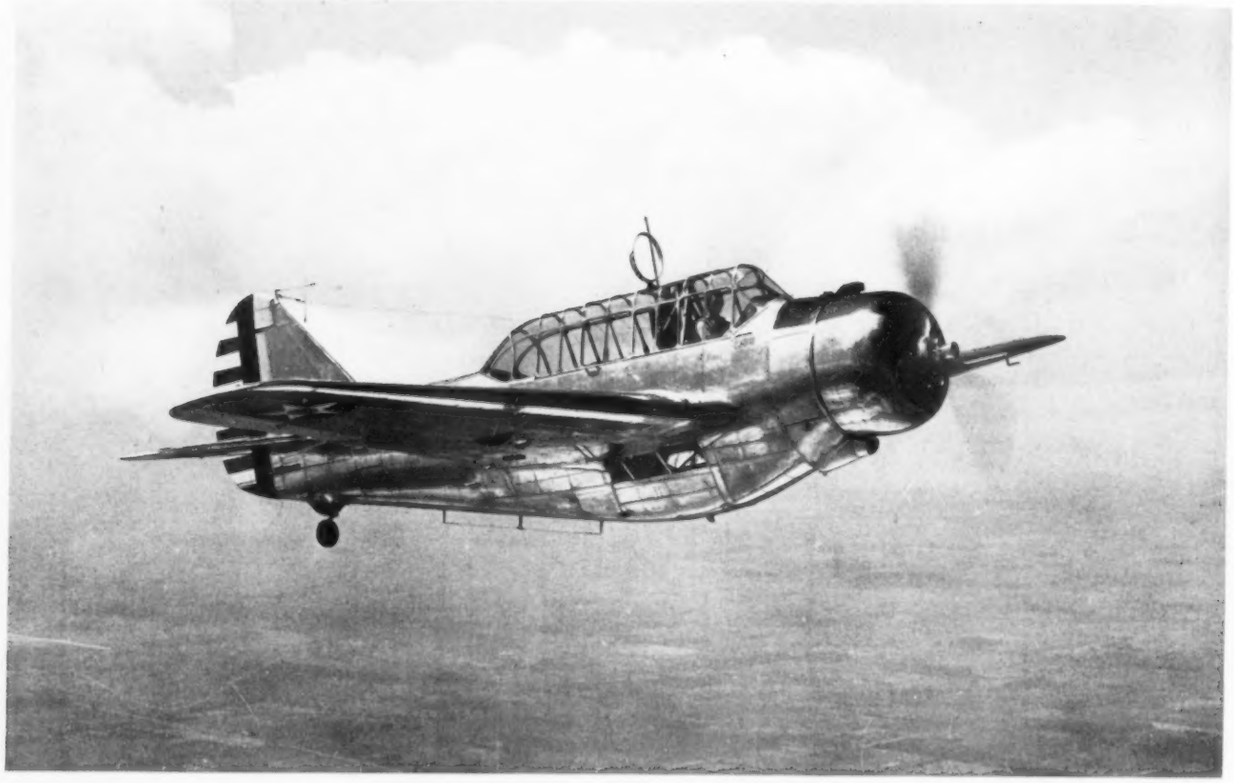
Automatic Cannon Are Replacing Machine Guns in Aircraft

The Bell YFM-1 fighter, above, is designed to conquer the modern heavily armed bomber. It is powered by two Allison 12-cylinder glycol-cooled engines mounting pusher propellers. It carries 2 automatic cannon, 4 machine guns and a crew of 5. The Vultee YA-19 attack bomber, below, carries 600 pounds of bombs and 6 guns at over 230 m.p.h.

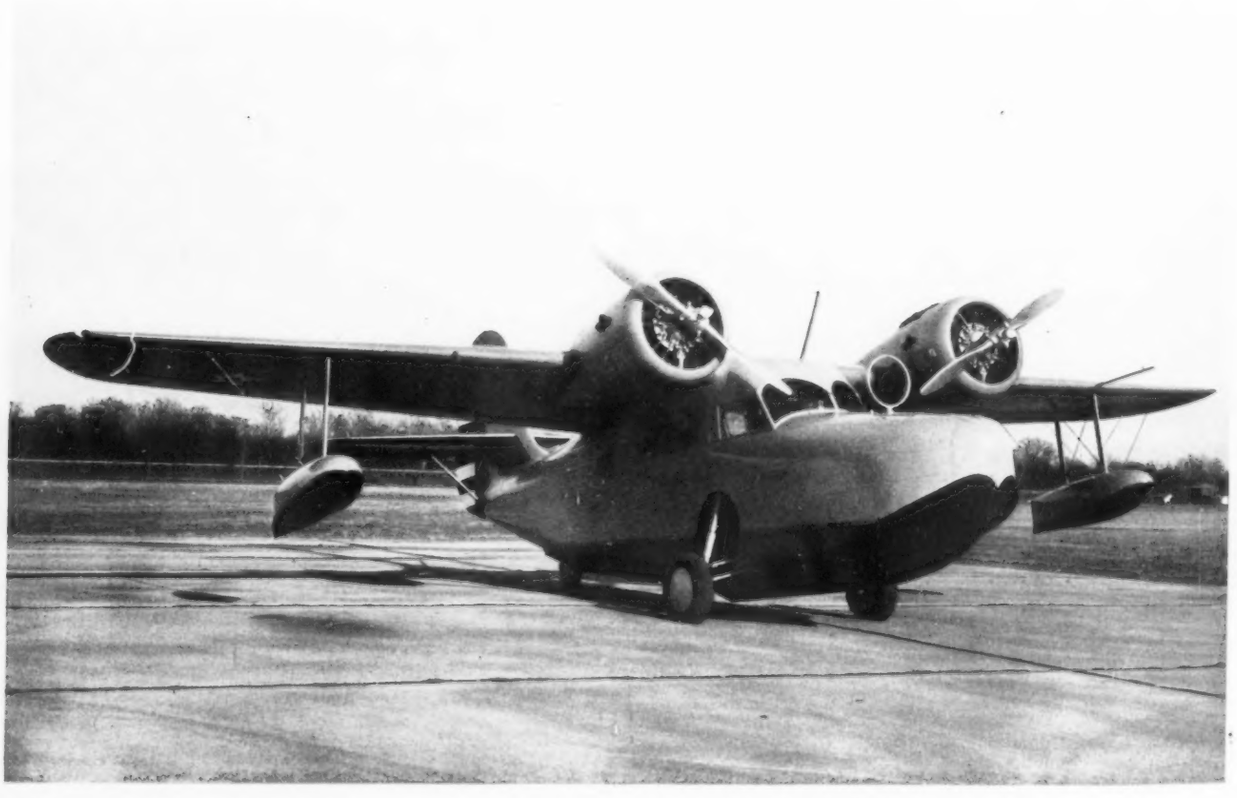
The Attack Bomber Is a New and Effective Combat Type

The Douglas X.A-20 attack bomber, above, is powered with two Pratt & Whitney 900-h.p. engines and is equipped with retractable tricycle landing gear. The Vultee BC-3 basic combat airplane, below, is an all-metal, low-wing monoplane with a ceiling of about 23,000 feet and a range of over 700 miles. It is used in the final stage of training combat pilots.

Observation Airplanes—the Eyes of the Army



The North American O-47A, above, is for detailed observation work immediately back of the enemy's lines and for liaison between headquarters and the front. Powered with an 850-h.p. Wright Cyclone engine, it has a speed of 236 m.p.h., a ceiling of 28,000 feet, a range of 880 miles, and carries 3 men. Below is the Grumann O.A-9 observation amphibian.



The Ideal Combat Unit

The "Triangular" versus the "Square" System of Organization

By Brig. Gen. Henry J. Reilly*

THE Industrial Revolution of the early nineteenth century at first caused but little change in the weapons employed in land warfare, but this slow start has been more than compensated for by the speed with which changes have taken place since the World War. The introduction of hand firearms and mobile cannon gradually effected a complete change not only in the armament but in the organization of the armies in Europe which, at the close of the eighteenth century, were very different from those at the beginning of the sixteenth.

This change gave birth to the infantry division because of the need for a combat unit capable of being handled by one man and, under ordinary circumstances, capable of holding its own alone. It consisted of foot soldiers, the backbone of the division, supported by the other arms which it habitually needed.

The new diversified armament, including the airplane, has greatly changed the condition of combat from what it was at the time the infantry division was born. The question, then, is not what changes are necessary in the World War infantry division to meet these new conditions, but what is the best unit organization for combat purposes, regardless of what the division was or can be made. There is no more need to be hypnotized by the word "division" and the mental picture it brings to mind than it was for the original organizers of the division to have been limited by the organization of a "battle." The only safe starting point is to take modern battle conditions and deduce from them a unit of combat which one man can command, which is flexible enough to meet readily the changing conditions of a battlefield, which can be supplied with ammunition and food at the time needed, and which, when on the road, does not get out of control because of undue length.

If such a deduction results in a combat unit practically the same as that of our new infantry division, then it is safe to accept that division as meeting the needs of combat as it is today and will be in the near future. If it does not, then it is safe to claim that successive amputations of units from our 1917-1919 infantry division, while facilitating command, supply, and transport problems, will not meet the conditions of modern combat.

In this case, why not free ourselves from the limitations the word "division" imposes on our minds and find a new name for the infantry-artillery team which meets effectively the conditions of modern combat? Some may say, "Why choose the infantry-artillery team as basic? Why not some fraction of the mechanized troops teamed with aviation—the two latest instruments of land warfare resulting from the Industrial Revolution?" The answer is that the last year of the Spanish Civil War furnished sufficient evidence to convince the Germans and Italians, as well as the Spaniards, that important as are these new instruments, the infantry-artillery team is the basic unit of hard combat. (The author spent 4½ months in Spain, visiting the front 20 times and witnessing 9 assaults, the smallest of 1 division, the largest of 2 army corps—8 divisions.)

Tanks and aviation play an important part in such combat, but as auxiliaries. More than that, to play this part they must have the support of the infantry-artillery team. In advance and rear-guard actions and in pursuit there is great need for mechanized troops and aviation, but the mechanized troops must include infantry and artillery. Even greater results are obtained when a considerable force of horse cavalry is available to cover the considerable amount of country in which mechanized troops cannot operate. In fact, if the maximum results are to be obtained from the powers of aviation in pursuit, horse cavalry is essential.

WHAT are the conditions the infantry-artillery team has to face on the modern battlefield? First, in defense, they must successfully resist, not only the artillery and infantry of the enemy, but armored tanks armed with cannon, aviation's heavy bombers, and attack airplanes diving with small bombs and machine guns. In offense, they must overcome the enemy's artillery, including antiaircraft and antitank guns; his mortars of various calibers; his machine guns, automatics, semiautomatics, and rifles.

The World War divided the battlefield into two zones with a gap between: the foremost zone, that of the assaulting infantry in which only small targets can continue to exist; the rearmost zone, the one in which large targets, such as the greater part of the artillery, have a chance to fire on the enemy without being exterminated almost immediately. The existence of these zones led to the infantry's demand for —and receipt of—such close-support artillery as mortars, minenwerfers, and one-pounders.

The Germans foresaw the trend of modern warfare by abandoning the 77-mm. gun and adopting the 105-mm. howitzer for the ordinary support of the infantry. The greater bursting charge in the 105-mm. shell and the high-angle fire which could reach targets the flat-trajectory 77 could not were both reasons for the change. An equally if not more important reason was that the 105-mm., being a howitzer, could find positions closer to the infantry than was possible with a flat-trajectory gun.

The Spanish Civil War accentuated the division of the battlefield. One of the signs of this was the possession by each regiment of Italian infantry of a battery of nine 65-mm. guns. It is this division which must govern a correct organization of the basic infantry-artillery combat team. As the task of the artillery is to support the infantry, the first question to be solved in determining the correct structure of the combat team is what should constitute the infantry organization.

There is no evidence that the battalion is not still the basic tactical organization. There is considerable evidence

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that it is. Its limits are fixed by the number of men one man—its commanding officer—can handle. It should not be overloaded with weapons which belong in the next higher echelon. It should have sufficient combat power in contradistinction to high fire power due solely to the rapid rate of fire of its weapons. In this regard, Maj. Gen. George A. Lynch, Chief of Infantry of the U. S. Army, has shown clearly that the *offensive* power of the soldier is not measured by the *rate of fire* of his weapon, and that therefore the offensive power of an attacking echelon is reduced if the number of men in it is reduced solely because the weapon of each has a greatly increased rate of fire. (See "Fire Power, Man Power, Maneuver," by General Lynch in the November-December 1939 issue of the *Infantry Journal.*)

IT IS in the battalion that the question of the "triangular" versus the "square" organization first seriously arises. Even the most vigorous supporter of the triangular system of three subdivisions to a unit instead of four cannot deny that flexibility is a highly desirable quality for any military body to possess. Any one who cares to experiment to determine the combinations possible with four safety matches, as compared with those possible with three, will soon be convinced that four subdivisions make the more flexible unit.

Therefore, a 4-company battalion is a more flexible unit than one of three companies. The increased difficulty of command in having four company commanders to deal with instead of three is more than offset by the increased flexibility. Since a 2-battalion regiment would lack both combat power and flexibility, the number of battalions that should constitute an infantry regiment lies between three and four.

Any one who will study the battles of the World War will find that again and again successful assaults failed to become decisive break-throughs. The reason nearly always was that the units making the assault had reached the limit of their power, and the time required to relieve them with new units gave the enemy the opportunity to recover himself. With modern weapons, modern battle more and more demands that the victor shall have the last reserve. This, admittedly true of the higher units, is also true of the smaller ones. The commander of each echelon in the attack must have under his hand for immediate use a reserve to give one more push without loss of time.

The year 1918 definitely put an end to the rigid time-table attack. The fighting of that year established beyond any doubt that the commander of each echelon must push just as far forward as he possibly can regardless of the echelons to his right and left. This means that each commander must be prepared to hold the salients in which he finds himself against counterattacks and to enlarge those salients with his own means. If he does not possess those means, fear of being cut off, surrounded, and probably forced to surrender, inevitably will cause him to halt, even though there is no resistance to his front. Frequently he will be justified in so halting until he can get additional support. But getting such support under the very best conditions means loss of valuable time. The probabilities are that his mechanical means of communication with the commander of the next higher echelon will have been cut and that any liaison agents he sends will be killed or wounded.

No such conditions existed in our Civil War—the war in which triangular organization was generally dominant. I say "generally" because, even though the specified organization was three regiments to a brigade, very often, as the war progressed, there would be four regiments and sometimes five. In that war, entire divisions and often army corps were visible to the eyes of their commanders. Therefore, they could see the need for reënforcements and dispatch them without delay. They did not have to wait until a messenger arrived from their subordinates telling of the need for support.

In the Battle of the Ourcq, the German position was on the hills on the far side of the Ourcq River where it made a long reëntrant curve. As a result, the four infantry regiments of the 42nd (Rainbow) Division (in which the author served) found it impossible to keep their direction of advance parallel as they attacked. The consequence was that their advance became more and more similar to four divergent spokes of a wheel. The inevitable result was that gaps opened out between the assault battalions of the different regiments, and the Germans naturally took advantage of these. By the second day of the assault, three of the regiments had two battalions each in the front line. Even this was not sufficient; two battalions had to be borrowed from the 4th Division, then in reserve.

While the 42nd Division carried the position, it took more time to do so and suffered far heavier losses than would have been the case had each regimental commander had four battalions instead of three. Also, the pursuit of the enemy from the Ourcq to the Vesle River could have been pushed harder and perhaps would have prevented the Germans from settling down in that new position had they not been given the time needed for the 4th Division to overtake and relieve the 42nd Division.

When the 42nd Division relieved the 1st Division in the Argonne, that division was occupying a salient which it had gallantly conquered at great loss. The result was that the 42nd Division went in with its four regiments echeloned from left to right, like four steps in a stairway. The Côte Dame Marie was in front of the 32nd Division to the right and the 168th Iowa, the right regiment of the 42nd. The Côte de Chatillon, at right angles to the Côte Dame Marie, blocked the advance of the 167th Alabama and looked down on the right flank of the 165th New York. From the north end of the Côte de Chatillon, the German position continued west in such a way that the 166th Ohio was echeloned to the left front of the 165th New York.

Without going into detail, it is quite evident that, as in the Battle of the Ourcq, this situation demanded additional battalions, not only to take care of the gaps between regiments, but also to furnish one more impulse after the right brigade (MacArthur) had captured the Côte de Chatillon. In the final attack, which carried the 42nd Division to the hills above Sedan on its left and the Meuse River on its right, due to the topography and the conflicting orders which caused a dislocation of the Franco-American advance, the left brigade could have used two more battalions.

IN all attacks made by the 42nd Division, except that at Saint-Mihiel, it was quite evident that a much greater result could have been produced had each infantry regiment had a fourth battalion immediately available. The 42nd Division habitually attacked with its four infantry regiments abreast, one battalion of each leading, one in support, and one in reserve.

This enabled the division to strike three hard blows by

passing each battalion into the assault position as the assault made by the preceding battalion was halted either by the enemy's resistance or by its own exhaustion. Both in the Battle of the Ourcq and in the Argonne, while the division advanced, it could have gone even farther had a fourth battalion been ready to immediately strike another blow instead of waiting until a new division could effect the relief of the 42nd and strike its first blow. The time between the third blow of the 42nd Division and the first blow of its relief inevitably was so great that the enemy was given a chance to recover and prepare himself.

The same was true in the one great defensive battle in which the 42nd Division participated—that of July 15, 1918. The Germans reached the main defensive position and broke into it in a number of places after a gallant advance over the forward zone of trenches—which contained enough defenders to give the impression that it was really the main position. Had the Germans possessed a few more fresh divisions to keep the attack going, only more reserves than the 42nd and the French divisions possessed could have prevented a break-through. A fourth battalion to each infantry regiment would have been a great comfort during the most critical hours of that last great German assault of the war.

One of the few criticisms which can be made of Gen. U. S. Grant was when he sent some of his artillery to the rear after the Battle of the Wilderness. Perhaps he was justified, for the field artillery had not yet benefited by the Industrial Revolution and was but little more powerful than in the days of Napoleon who, incidentally, owed much of his success to the fact that he was an artilleryman. However, there can be no doubt in any one's mind today that it is absolutely essential to have enough artillery to prepare the way and support the infantry attack, so that the infantry may drive the enemy from his position without undue losses to themselves.

That the artillery assigned to a division during the World War was insufficient is proved by the fact that for each assault it had to be at least doubled by adding to it the artillery of a reserve division. Even then, assault was not always successful. When it was, the price paid by the infantry frequently was high. Summerall's attack, in which the artillery of three divisions was used to support the advance of the infantry of one, by its rapid success and the small loss of the assaulting troops is the best possible demonstration of what sufficient artillery can accomplish. The author, who was in command of the infantry brigade through which the attack of the 2nd Division passed and who had had a part in the preparation of the artillery plan and the heavy-machine-gun plan, went over the ground shortly after the attack. The evidence was there of what little chance the German infantry had to resist as the result of the heavy artillery pounding they received.

Franco's success in the Spanish Civil War was due largely to his insistence that no attacks be made without the support of both heavy artillery and air bombardment.

As a result of the experience of 1917-1918, it can safely be said that each regiment of infantry usually needs a minimum of twenty-four light field weapons for its support—either 75-mm. guns or 105-mm. howitzers, or both. The two battalions of 155-mm. howitzers generally assigned to each brigade of infantry in the World War are not habitually necessary and, therefore, are more properly assigned to the next higher unit than to the fundamental combat unit.

This means forty-eight light field guns or howitzers to an infantry brigade of two regiments, or four battalions, following the present American organization of twelve guns to a battalion. The author, as is true of most field-artillery colonels of 1917-1918, knows from personal experience in battle that a colonel can handle four battalions. Recent experiments with the new division support this statement.

EIGHT battalions of infantry and four of artillery compose an infantry-artillery team of considerable combat power. This is about the largest combat unit that can be handled by one commander. When the antiaircraft and antitank guns demanded by modern warfare are added, there is little doubt but that anything larger goes beyond a basic unit of the infantry-artillery team.

During the World War, the author, first as an artillery regimental and then as an infantry brigade commander, was impressed, again and again, with the fact that the infantry brigade of two regiments supported by adequate artillery was really the combat unit and not the division composed of one artillery and two infantry brigades. He knows of no case in which, if each infantry regiment had four battalions, the question of command would have been more difficult. In fact, the greater flexibility resulting from the possession of eight rather than six infantry battalions, would have simplified command problems.

For a colonel of infantry to command four battalions is no new problem. In the days of Tzarist Russia it was a commonplace. The British brigadier (who is a colonel with the temporary rank of brigadier) commanded four battalions until lack of replacements robbed him of one of them. As a result of their experience in Spain, the Italians have adopted a basic infantry-artillery team of two regiments of infantry with accompanying artillery.

During the Spanish Civil War the author watched the evolution of the Italian 3-regiment infantry unit into a 2-regiment one. The Italian expeditionary force originally landed in Spain consisted at its maximum, not including aviation, of an army corps of three infantry divisions and the cadre of officers and twenty-five per cent of the enlisted men for two infantry brigades of two regiments each. These brigades were filled up with Spaniards. The three infantry divisions were each of three regiments numbered from one to nine inclusive, all newly organized from volunteers, many of whom had seen service in Abyssinia. The cadres of the two infantry brigades were also volunteers. The higher ranking officers all had served in the World War. Quite a number of officers had ribbons from the Turkish campaign, the World War, and the Abyssinian campaign. Therefore, besides their military education as professional officers, they had had considerable and varied war experience. Some were reserve officers who volunteered because of the spirit of adventure. Many of the regulars were ambitious officers who chose this route to increase their knowledge of war and chance of advancement.

There is no doubt that under Mussolini the adventurous and ambitious officers and enlisted men have opportunities for advancement previously denied them. The more the author talked to them and saw them on and off the battlefield, the more he was impressed with their open minds on military subjects and their desire to use their war experience to better the organization, armament, and tactics of the Italian Army.

The two brigades were from the first used as independent reënforced brigades or small divisions. They usually served with Spanish infantry divisions in some Spanish army corps. As practically no replacements were sent from Italy, one of the three infantry divisions of the Italian army corps was disbanded and used to make good the losses of the two others. Finally for the last campaign—the Catalonian—the two remaining divisions were reduced to two regiments each, thus giving the Italians four reënforced brigades, each of two regiments of infantry with attached artillery. The corps had mechanized weapons of all types.

THE performance of these reënforced brigades during the Catalonian campaign convinced the Italians that from the point of view of combat, command, transportation, and supply, these units constituted the best "divisions" for modern war.

General Batisti, who commanded one of them, was chief of infantry of the Twenty-third of March Division when the author, shortly after his arrival in Spain, first met him. We had many long discussions on organization, armament, and tactics. He took me over the ground of the advance of the Italian army corps in the early spring of 1938. I had arrived just as this advance terminated on the Ebro River at the same time that the Spaniards, on the right of the Italians, reached the Mediterranean at Vinaroz. He, in more detail than others, gave the reason why the Italians, although they had found from their own war experience that the 4-regiment division was too large, also found that amputation to three regiments was not the answer. The reason was that for combat, command, and movement in the face of the enemy, the 3-regiment division also was awkward. In other words, if four regiments had become too large because of the increased artillery necessary, then a 2-regiment division was the answer. Later, in Rome, General Pariani, then Assistant Secretary of War and Chief of Staff, whom I had met on a previous visit, took the trouble to discuss the subject thoroughly and also show me why the Italian Army was being reorganized into 2-regiment divisions.

The Italian experiments have been conducted to obtain an organization which will possess offensive power, mobility, and flexibility of command. Combat experience in Spain emphasized the fact that improvements in weapons and in means of transportation are not alone sufficient bases of changes in organization.

The Spanish campaign once more proved that the new weapons and means of transportation must be fitted into the strategic and tactical situations of war as they actually exist. War cannot be wrenched away from such fundamentals as terrain, human nature, and man's physical vulnerability.

The Spanish War emphasized the following points: 1. An increase in the rate of fire and the range of individual weapons does not, *per se,* increase offensive power. 2. Speed and mobility are not synonomous. 3. Increased speed to obtain protection from enemy fire frequently results in loss of offensive power.

In other words, the fact that the rate of fire of the new semiautomatic rifle is 2½ times as great as that of the Springfield does not mean that the offensive power of 100 infantry soldiers armed with them is equal to a company of 250 armed with the Springfield.

The fact that the improved 75-mm. gun will fire up to 13,500 yards, where formerly it could only reach 9,700 yards, does not make it any more effective to blast out enemy infantry from positions 3,000 yards distant.

THE new American division lacks combat power. It has only 27 companies of infantry and but 36 light field guns and 18 antitank cannon.

The infantry-artillery combat unit proposed in this article would have 32 companies of infantry, 48 light field guns or howitzers and, if the German proportion of antitank cannon (the maximum) is used, it would have 3 per battalion or 24 in the hands of the infantry and the same number in the hands of the commanding general—a total of 48.

The new division is overloaded with sixteen 155-mm. howitzers and the proportion of services which can be dispensed with by eliminating the following: the howitzer regiment, one infantry regimental overhead, one battalion of infantry overhead (eight battalions instead of nine), an infantry section, and an artillery section in division headquarters.

Command in the proposed combat unit would be facilitated by having only three colonels—two infantry and one artillery—under the commanding general. The Signal Corps would have only four headquarters with which to deal instead of the six and possibly eight when both the infantry brigadier and the artillery brigadier are given commands.

In any assault except on a weak enemy the new division must ask for and await the arrival of artillery from the next higher echelon. The infantry-artillery combat unit proposed above would have all the artillery needed, except for assaults on a carefully prepared, well-defended position.

The new division does not readily lend itself to being divided into two parts, each to advance on one of two parallel roads. This is a problem frequently met with in war. The proposed infantry-artillery team readily could be divided into two columns.

The new division, having five regiments to three of the proposed infantry-artillery team, cannot be as easily supplied.

Incidentally, in an army such as ours, which has to conform to laws passed to satisfy Congressional ideas and to facilitate the work of governmental auditors and clerks instead of to meet military requirements in time of war, the paper work would be much less with the proposed infantry-artillery team.

Just what we call the infantry-artillery team makes little difference. After all, in our Civil War, where the worship of the triangle system originated, the 3-regiment infantry "brigade" was merely a regiment of 3 battalions, each of 10 companies of 1,000 men. As a matter of fact, the Regular infantry regiments were originally ordered to comprise 3 battalions of 10 companies each. This meant regiments of 3,000 rifles, the usual European practice. Thus, the Civil War division was in reality one of 3 regiments of 3 battalions of 1,000 rifles each, or a total of 9,000 rifles. Therefore, it was 3,000 rifles weaker than the standard Western European division of 12,000 rifles, and 7,000 rifles weaker than the 16,000-rifle Russian divisions.

Consequently, our Civil War nomenclature of "regiment," "brigade," and "division" brought to the European mind a very different picture from that brought to the American mind. Why not disregard nomenclature in reorganizing our Army to meet the new conditions brought about by the new war instruments? Instead, why not organize on the basis of combat power and its efficient handling in battle?

Optics and Defense

A Study of Emergency Production of Glass and Instruments

By Carl L. Bausch*

OPTICAL instruments constitute a very essential part of the equipment needed by modern armed forces in the conduct of a major war. Binoculars, telescopes, periscopes, range finders, aiming devices, and other necessary items using optical glass all will be required in large quantities. At the same time, quality must be maintained at a standard that will not lessen the efficiency of the instruments.

Thus, adequacy of quantity and quality is the problem that will confront the United States optical industry in an emergency. It is a problem that is now well on its way toward solution due to the improving conditions in the industry itself and to the close coöperation of the Army and the Navy in giving a clearer picture of the demands that will be placed upon the industry in war time.

No manufacturer can get much satisfaction in aiding war planning unless he knows the full story of what is expected from him and his industry as a whole. The optical industry is in an enviable position in this respect because it is relatively small and the problems are now fairly definite.

Some years ago, when the Army, Navy, and Air Corps all were working independently, it was quite difficult to do any intelligent planning. It was possible to give capacities on any specific current request, but that plan became obsolete as soon as the next request came along for a statement on capacity for something else. It now appears that the Army and Navy Munitions Board has a plan that is as complete as practicable at this time; it gives the manufacturer confidence that his planning, in turn, is not futile. It is essential that this feeling of confidence be present when a manufacturer is asked to coöperate in a planning program. However, the constantly decreasing supply of skilled labor is a disturbing phase of the problem.

Although I am writing about the optical industry as a whole, my observations must be confined to a large extent to the Bausch & Lomb Optical Company because of lack of complete information about other manufacturers.

To one making a study of the optical industry, the United States census reports are confusing because a part of the industry is classed with "Manufacturers of Optical Goods" and part with "Manufacturers of Instrument Apparatus—Professional, Scientific, Commercial, and Industrial." In 1937 the census showed these figures for the two classes of industry:

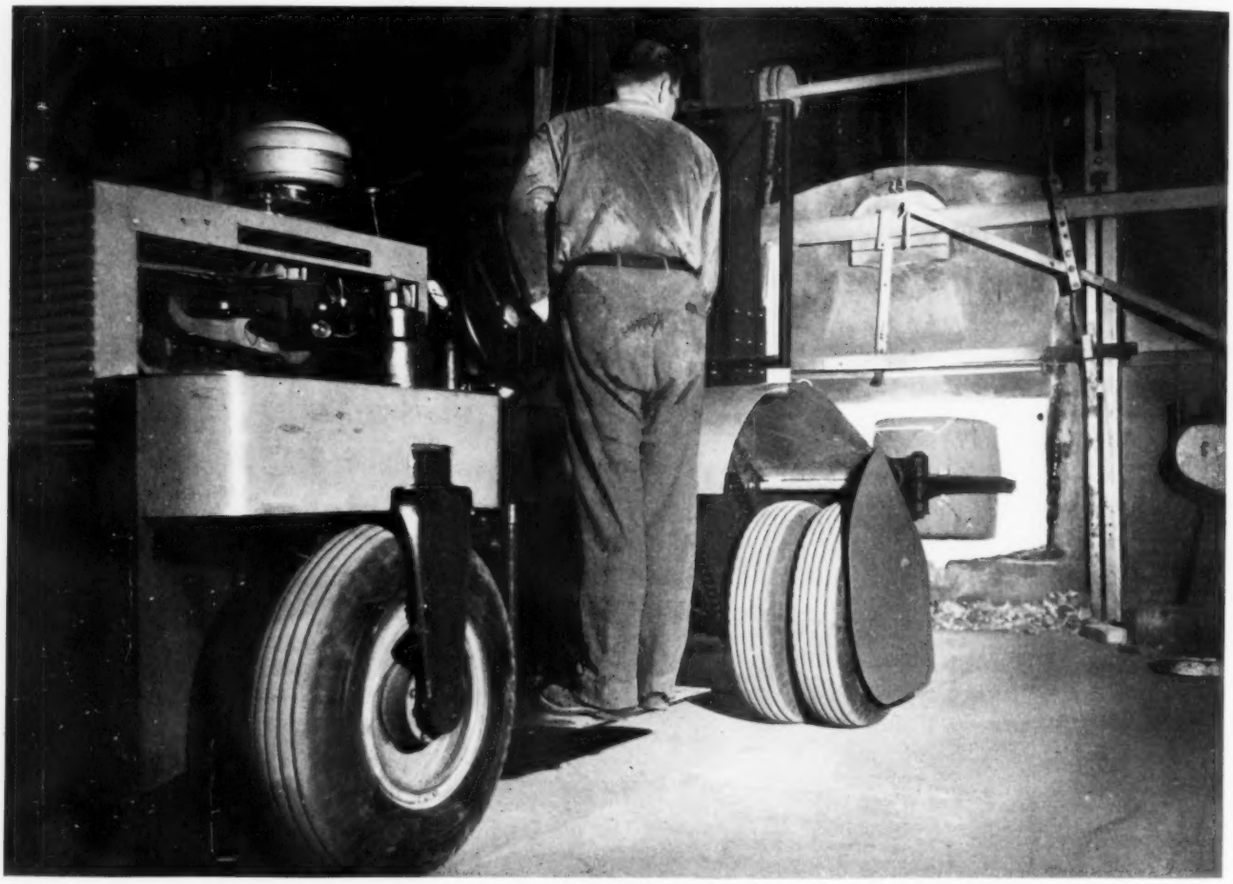
	Optical Goods	*Instrument*
Number of establishments	96	283
Wage earners	11,998	17,399
Value of production	$47,461,134	$96,013,179

THE problems I will discuss here are those of the industry making optical glass, range and height finders, gun sights, photographic lenses, telescopes, binocular field glasses, periscopes, microscopes, drift meters, sextants, aërial mapping projectors, etc. I believe there are less than a half dozen concerns employing over one hundred persons each engaged in this class of work. These are the manufacturers mostly concerned with the war load. There are many other small concerns that can help, but proportionally the number will be small. My estimate is that the number of present employees of these plants qualified to make instruments of the kind listed is not more than 4,000.

Since optical glass is the basis of optical-instrument fabrication, a short account of the history of its manufacture in the United States is in order here. In 1912, William Bausch employed a Belgian glass maker to do some experimental work with him. These two men worked alone until the start of the World War in 1914 when the foreign supply of optical glass was shut off. This forced greater activity, and when the United States went into the war in 1917, production was going on in a small way. During this time, the Bureau of Standards, Keuffel & Esser, Spencer Lens Company, and the Pittsburgh Plate Glass Company also had started to manufacture optical glass. When the United States declared war, the services were confronted with the fact that many optical instruments were needed, but the bottle neck in their procurement was the supply of optical glass. Through Government requests, aid was given optical-glass manufacturers to enable them to increase their production. Dr. A. L. Day, Col. Fred A. Wright of the Geophysical Laboratory of the Carnegie Institution, and a staff of a dozen experienced men were assigned to the Bausch & Lomb Optical Company plant. Similar staffs were assigned to assist the other glass plants. Work was started in earnest, with the result that although only 2,850 pounds of glass were produced in April 1917, by October 1918 production was increased to 79,275 pounds.

The following quotation is from the "Manufacture of Optical Glass and Optical Systems," published by the Ordnance Department in May 1921: "The records show that there were produced in this country between April 1917 and November 1918 over 600,000 pounds of usable optical glass. Not all of this glass was of the best quality, but it was satisfactory for low-power optical instruments, and some of the product was of the highest quality, equal to the best European glass. On an average, its quality was fair and satisfactory for war-time purposes. Six different types of glass were manufactured: ordinary crown, borosilicate crown, barium crown, dense barium crown, light flint, and dense flint. The Bausch & Lomb Optical Company produced over sixty-five per cent, Pittsburgh Plate Glass Company nearly twenty per cent, the Spencer Lens Company nearly ten per cent, and the remaining five per cent was produced by the other firms, including the Bureau of Standards. The figures, especially those for 1917, are less accurate than those for 1918, but they are of the correct order of magnitude. The figures show that starting with the total monthly production of 1½ tons of usable glass in April 1917, the monthly production amounted to about 40 tons in October 1918. The organizations at that time were, moreover, so well coördinated that an increase of fifty per cent in the monthly production could have been attained had the need arisen."

*Assistant chief, Rochester Ordnance District.



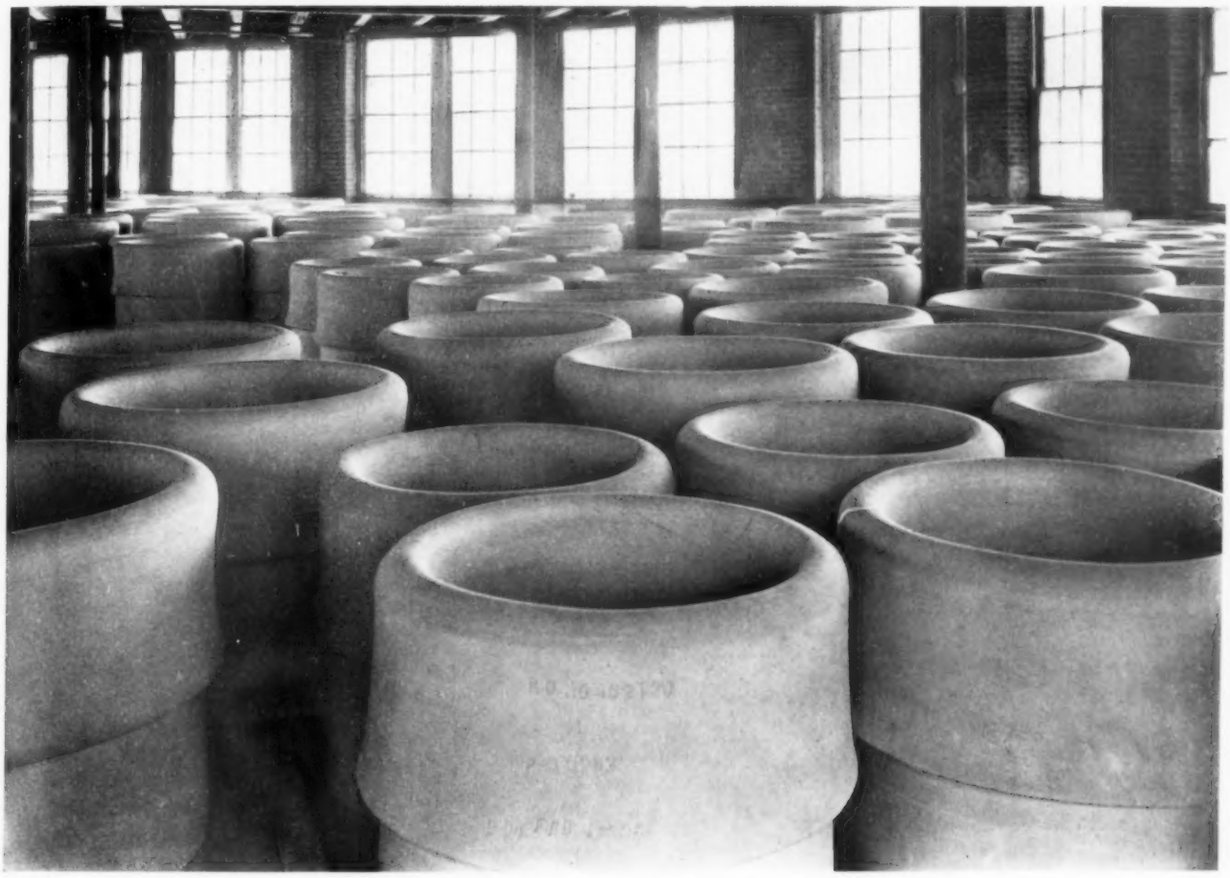
A NEW TYPE TRUCK TRANSFERS THE MOLTEN GLASS FROM THE FURNACE TO A CASTING TABLE

BAUSCH & LOMB is now making twenty-four types of optical glass, and also about a dozen different types of filter glasses that have been developed recently. The present monthly capacity is about 10,000 pounds per month, which means about 500 pots per year. The present equipment would make about 1,000 pots per year. This capacity could be doubled easily within a month or two. At the present time there are about fifteen types of glass that are designated in the different Government requirements. In addition to the optical glass, about 75,000 pounds of ophthalmic crown and flint are made per month. This ophthalmic glass is a simple type of optical glass used practically only in the manufacture of spectacle lenses. An inventory of about 35,000 pounds of optical glass is being carried as standard procedure, and about 300 pots are carried in inventory. These inventories have been on the increase for the last three or four years, and during the next year undoubtedly will jump upward rapidly.

EXAMINING SOME OF THE LARGEST QUARTZ PRISMS EVER MADE IN THIS COUNTRY

Practically all materials now used in glass making come from domestic sources, with the exception of nitrates which come from Chile in their crude form and are purified here.

During the last year a great deal of development work has been done on increasing the size of pots used in glass making and changing the method of manufacture from hand-made to cast pots. Very good results have been accomplished which make it possible to say that the choke point in glass making is no longer the procurement of sufficient and suitable melting pots. The development in pot making plus the fact that the Army and Navy are building up fairly large inventories of optical glass, remove the old fear that a shortage of optical glass will interfere seriously with the production of optical instruments in a future emergency. I feel very confident that the bottle neck has been transferred



THESE SEMIPORCELAIN POTS ARE NOW MADE BY IMPROVED METHODS IN THREE INSTEAD OF EIGHT MONTHS

from the manufacture of glass to the manufacture of optical parts and to the assembly and adjustment of the instruments.

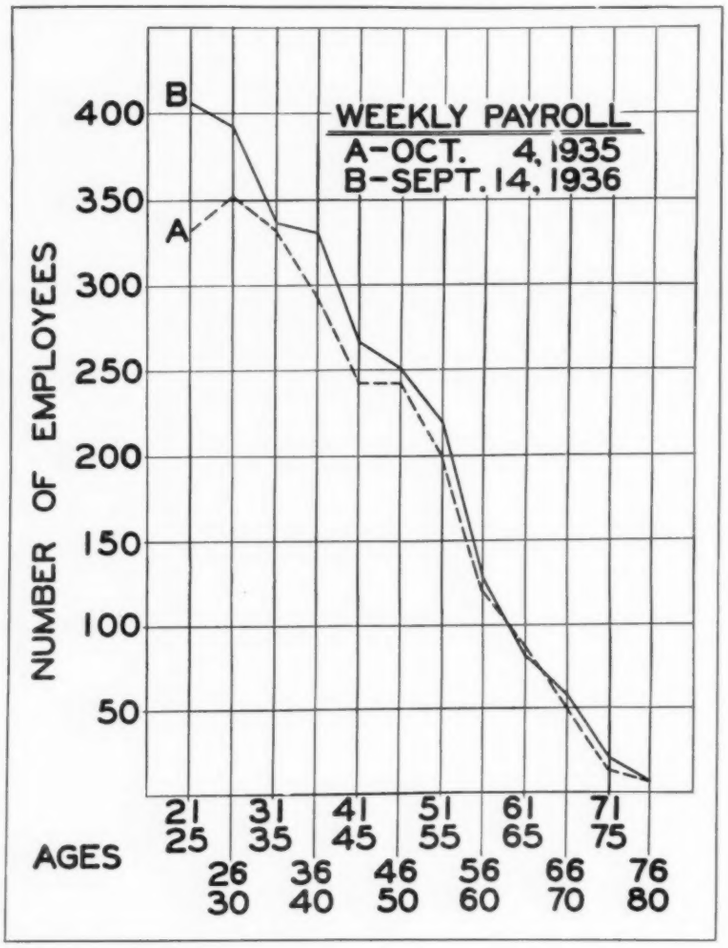
The manufacture of optical instruments properly can be divided into three divisions: the manufacture of optical parts, the manufacture of mechanical parts, and the assembly and adjustment of optical instruments. Although these functions can be separated theoretically, undoubtedly greater efficiency in manufacturing can be maintained by their close coördination. Operating as separate divisions, as contemplated to some extent in the emergency plans, forces the large-scale use of special tools, gages, and testing apparatus. This in turn involves an engineering and design problem that the industry is not very well equipped to assume. Another difficulty in working on a separate basis is that the degree of accuracy required in optical-instrument construction is so great that it is not economical to work to the finished accuracy required in all cases. Fitting parts to parts and optics to mountings often is practically necessary to produce on a commercial basis.

TESTING OPTICAL AXIS AND IMAGE QUALITY OF BINOCULARS

Undoubtedly, the regular optical-instrument manufacturers will be required to carry the main load if an emergency comes. To give an idea of what they must do, I will outline the situation in the Bausch & Lomb Optical Company plant. Company officials met with the Army and Navy Munitions Board and discussed the complete manufacturing program on optical instruments of the type they would be called upon to manufacture in case of an emergency. This plan showed the number of instrument items which would be built by Bausch & Lomb.

BASED on knowledge of conditions and guided largely by the experience of the World War, we decided that we could increase the output of our instrument plant five times in dollars-and-cents value of product in the first three

years of an emergency. We assume that we would be allowed to carry on about one-half of our normal commercial business. We figured it would be necessary to work three, 8-hour shifts or, preferably, two 10- or 12-hour shifts. We would have to add 4,000 more employees to our payroll and transfer some from our ophthalmic to our optical-instrument department. We would have to add a great deal of new machinery. Some of this machinery would be of standard type but much of it would have to be specially built in job shops. All this equipment should be built the first year of the war in order to meet our plans. To get the proper floor space, we would have to take over a building that we are now renting. Military exemption for our entire force would be necessary. We would have to procure several million dollars' worth of materials per year, largely brass and aluminum rods and tubes. Inspection standards would have to be lowered to some extent regarding the elimination of all so-called beauty defects, but not in a way to harm the functioning of the instruments. The plan outlined would mean that we would be turning out about twenty times the present output of military instruments being made by the company. This would be about one-third of the total requirement called for by the emergency plans.



AGE BRACKETS AND INCREASE IN NUMBER OF EMPLOYEES OF THE BAUSCH & LOMB OPTICAL COMPANY

One who had not been through the pressure of the World War and had not seen what could be accomplished, would consider the contemplated program visionary and impossible; as based upon present procedure it certainly appears that way. However, there is probably a serious fallacy in taking the experience of the World War in preparing a program for a future emergency. In 1917 there was a fair supply of skilled mechanics. During the recent years of depression, mechanics have not been trained as they were previously, and I think it is safe to say that the available supply of trained mechanics today is less than it was in 1917. During business depression, many manufacturers are not in a position to maintain apprenticeship courses, and I believe that during the last few more prosperous years many manufacturers have been prevented from doing so because of labor-union activities.

Without skilled labor available, it will be necessary to recruit younger employees into our organizations to increase production, as young workers learn a new job much faster than mature ones. The chart on this page illustrates what took place in the Bausch & Lomb plant during an expansion period, 1935 to 1936. Here are shown the number of people in different age brackets before and after the expansion. A very large portion of the new employees were of military age. The older persons put on were almost all experienced workers, many of whom had been employed by us before. At present about seventeen per cent of our employees are women. I believe this percentage can be increased to some extent. During the World War our women employees were twenty-two per cent of the total. It was mentioned above that emergency plans call for employing 4,000 people. These will be divided as follows: Glass plant 200; optical-parts work 1,000; manufacture of mechanical parts 1,000; assembling and adjusting 1,500; toolmakers, etc., 300.

Cheap competition from some foreign countries is still a serious threat to the optical-instrument industry. The ophthalmic industry, which manufactures spectacle lenses, is much harder hit by this foreign competition. Since the ophthalmic business is a feeder for the optical industry, as far as the personnel goes, a serious condition is presented. Last year, Japan imported 1,800,000 pairs of spectacle lenses into this country at prices far below American costs. Investigation of wages paid lens grinders in Japan showed the wage of men to be $0.07 per hour and that of women $0.03 per hour. Microscopes now are being imported into this country from Japan at about one-half the selling price of American instruments. To date, the quality has not been good enough to make this a serious threat, but it might easily become such.

Although the emergency program proposed to the optical industry is a huge one, from my knowledge of conditions I would say that it is no longer a decided bottle neck. I feel quite confident it can rise to the situation and keep step with the rest of industry in preparing our Army and Navy for any emergency. Our optical industry in time of war, as in peace, can be depended upon to give its best effort and cooperation for the national defense of our country.

Military High Explosives

The Types Used in Artillery Ammunition in Our Service

By Capt. Carl R. Dutton*

FROM the time of the invention of black powder until the beginning of the nineteenth century, no other explosive found general acceptance. During that period and for some time after, attempts to improve upon the mechanical mixture of potassium nitrate, sulphur, and charcoal resulted in sulphurless gunpowder, such as that of LeBlond in 1756, in gunpowder without charcoal, such as the "coal brasses" of De-Lavel in 1766, and in the numerous mixtures in which barium and sodium, or ammonium nitrates, chlorates, and perchlorates were substituted for niter. These met with little success in overcoming the inherent shortcomings of black powder as a military explosive. The inventions of guncotton by Schoenbein in 1846, of nitroglycerin by Sobrero a year later, and of Sprengel's explosives in 1873 were real milestones. In discovering the use of mercury fulminate in the initial ignition of nitroglycerin, Nobel accomplished a great advance in the field of explosives science. The status of military explosives, however, was not greatly affected.

METHOD OF STOWING BOMBS FOR RAIL SHIPMENT

A stagnant interval during which nothing of note occurred was suddenly interrupted in 1886 by Eugene Turpin's discovery that picric acid could be used as a shell filler and had great detonating power. Immediately investigations, inventions, and developments followed in rapid succession, giving to this new explosive the position of highest importance which it maintained until the end of the century. The remarkable part is that this compound had been known as an artificial dye for many years, and in 1873 Sprengel actually had called attention to the detonating property of pure picric acid. Moreover, chemists had known how desirable it would be to replace black powder, which is essentially a mechanical mixture of a combustible and an oxidizer, by a stable chemical compound with the combustibles, carbon and hydrogen, existing in close contact with oxygen in the same molecule.

Although Laurent had shown that picric acid is 2, 4, 6-trinitrophenol and had produced it by nitrating phenol as early as 1843, the commercial manufacture of picric acid in relatively large quantities came only after the development of the synthetic-dyestuff industry which had its genesis in the discovery of a 17-year-old boy who stayed at school over the Christmas holidays hoping to synthesize quinine from aniline. Thus, in 1856, W. H. Perkin made the world's first synthetic dye, using coal tar—the refuse of gas works. His discovery created a much-increased demand for coal tar, which is the most important source of the aromatic hydrocarbon compounds from which dyes and explosives alike are made, and naturally led to a rapid extension in the distillation of coal. The coal-tar industry had been gradually growing in a quiet way as a result of the Solvay alkali process which required quantities of ammonia from the by-product coke oven. Its sudden and rapid growth to keep pace with the new dyestuff industry is another story, but the fact that the explosives industry is an outgrowth of the latter must be remembered. Development of these two has gone hand in hand.

The realization of the chemical and physical stability of picric acid, its insensitiveness to temperature changes, its non-hygroscopicity, its ability to withstand the shock of the discharge of guns of large caliber, and its remarkable brisance and power when properly detonated led to its investigation as a disruptive agent by nearly every country. Thorough tests were made which proved it a desirable explosive for military purposes, and these results, together with its easy and cheap manufacture and its great density when properly loaded into shell, caused it to be adopted as the melinite of France, the lyddite of England, and the shimose of Japan.

BUT the other side of the picture showed some disconcerting facts. In order to increase the density over that of the crystalline material, a shell filler must be melted or compressed. Picric acid has a high melting point (122.5 degrees Centigrade) which requires that it be heated to a temperature of 130 to 135 degrees Centigrade for melt loading into shell. While the pure compound in small quantities may be so heated, as soon as it comes into contact with metals, metallic oxides, brickwork, or any substances with which it can, by virtue of its acidic character, form picrates, a hazardous condition arises. Serious accidents have been attributed to the formation of sensitive lead picrate which in turn has caused the detonation of the remaining picric acid. Its manufacture and use are, moreover, unpleasant to workers. Being a dye, its vapors impart an intense yellow coloration to the clothing, hair, and skin which has given the name "canary birds" to picric-acid workers in some districts.

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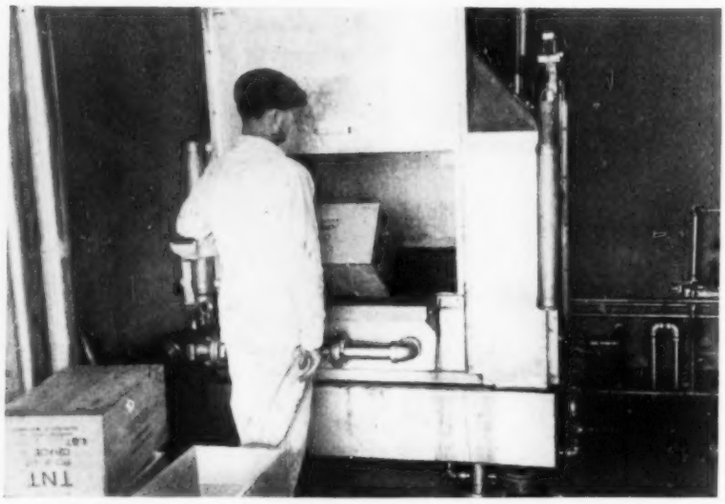
To obviate these drawbacks, endeavors were made to make the material more easily fusible by the addition of various organic substances on the principle that a mixture of two substances of high melting point has nearly always a lower melting point than either of its constituents. When nitronaphthalene with a melting point of 61 degrees Centigrade was added to picric acid (melting point 122 degrees Centigrade) in equal proportions the melting point of the mixture was lowered to 49 degrees Centigrade. Likewise dinitrotoluene, trinitrotoluene and trinitrocresol have each been used to mix with picric acid for this purpose.



A CONTINUOUS MELTING UNIT FOR TNT

Another method of attack was to place a mixture of picric acid with a lower-melting compound, such as TNT, in suitable molds which were raised to a temperature slightly higher than the melting point of the added compound. In this manner the picric-acid crystals were fritted together so that a dense mass would result upon cooling.

Concurrently with these efforts to overcome the disadvantages of the high melting point of picric acid, many mixtures purporting to result in a better oxygen-balanced explosive were developed. The materials added were variously tar, sawdust, paraffin, various nitrates and chlorates, collodion cotton, etc. In general, these were less brisant than picric acid, but this was rather an advantage since frequently the latter caused a higher degree of shattering of the shell than was desired. However, the property of picric acid which causes it to displace other acids and as a result to set free nitric acid from nitrates caused these mixtures with inorganic chemical compounds to lack adequate chemical stability for storage.

While picric acid was being used, the nitrated cresols and resorcins were proposed. These compounds are very similar to picric acid but had some advantage in possessing lower melting points than the latter and in being less soluble in water with the consequent lessened likelihood of attacking metals. A disadvantage remained in the fact that greater difficulty was experienced in detonating such compounds.

The advantages over picric acid were sufficient, however, so that France saw fit to adopt a mixture of picric acid and trinitrocresol as a shell filler which was called cressylite. Austria adopted ekrasite which was the ammonium salt of trinitrocresol.

WITH the advent of the twentieth century the use of these explosives had become general in other countries when a new discovery in the chemical industry made the manufacture of a better explosive possible. This discovery was the contact method of manufacturing sulphuric acid, and with it came a complete change in the chemical industry as a whole and in the dyestuff and explosives industries in particular.

Prior to the final solution of the problem of the manufacture of an inexpensive concentrated sulphuric acid in Germany by the scientists of the Badischen Anilin-und Sodafabrik and by Rudolph Messlin in Great Britain, the less concentrated acid made by the lead-chamber process had been used. When more concentrated acid was required in the manufacture of dyes and other organic compounds it was necessary to carry out a costly concentrating process on the lead-chamber acid. The greater the need of the consumers the greater became their discontent.

Finally a chemical inquiry was started to ascertain why a sulphuric-acid process on which a patent had been granted an English vinegar maker, Peregrine Phillips, had not worked. The process was simple. It consisted of passing sulphur dioxide and air over a hot platinum catalyst causing them to combine to form sulphur trioxide. This, dissolved in water, made sulphuric acid of any desired concentration. But the problem of finding out why the platinum did not continue to function proved a hard one, and even after it had been shown that impurities in the sulphur dioxide poisoned the catalyst, the process accounted for very little production until Herman Frasch brought ninety-nine per cent pure sulphur up from the quicksands of the Louisiana coast to make pure sulphur dioxide.

Once this chain of events was accomplished, it became possible to place highly concentrated acids on the market at reasonable prices. This made possible the successful competition between the less reactive, harder-to-nitrate aromatic hydrocarbons and the very reactive phenols which could be nitrated readily with dilute acids. It also made possible the introduction and use of an explosive which to this day remains at the top of the list of disruptive explosives for military use. The explosive is trinitrotoluene, commonly called TNT. Here was an explosive which possessed all the favorable properties of picric acid and but few of its disadvantages. With its melting point of eighty degrees Centigrade it can be melted readily, poured into shells or bombs and allowed to solidify. Its vapors are not extremely disagreeable nor toxic. TNT is quite safe to handle, it does not combine with metals and, generally, has no acid properties. Although it can be detonated readily by means of mercury fulminate, a rifle bullet may be fired through a solid mass without causing explosion. It successfully withstands tremendous accelerating forces when fired from guns of all calibers and has upon occasion been used in armor-piercing shell, although the standard practice in this country has been to use Explosive D, which is ammonium picrate, for loading into shells to be fired through armor plate.

Even the lower bursting effect of trinitrotoluene, as compared with picric acid, is only a minor disadvantage since, in the fragmentation of a shell, the pieces are sufficiently large to have the desired destructive effect. In addition, the

availability of toluol in coal tar exceeds that of phenol.

As a result of these favorable properties, TNT was taken up as a military explosive by Germany where, in 1901, the Carbonit Gesellschaft, followed quickly by other firms, went seriously into the business of its manufacture. Italy, Spain, and Russia followed suit. Ultimately, by the time of the World War almost all other countries had adopted TNT. The essential raw material for the manufacture of TNT is toluene, the chief source of which was the by-product coke ovens.

PRIOR to the World War in 1914, the quantities of crude toluol and the facilities for refining it so that it could be nitrated were considered adequate by most countries. It is said that the French general staff planned at the beginning of the war to use less than 300,000 pounds a month, but by 1918 the actual amounts used exceeded 2,000,000 pounds a month. Similar statements might be made about all the belligerents.

Shortly after the outbreak of the war, it was recognized that the supply of raw material to manufacture either TNT or picric acid would not meet the requirements. It became necessary, therefore, to consider substitutes which, although not possessing all the desirable properties of TNT, might suitably meet the minimum specifications. A good explosive for use in loading artillery shell must not undergo any change from its original condition upon long storage at either high or low atmospheric temperatures. This requirement probably meant little in the rush of war as long storage was not contemplated, whereas in peace time it is of paramount concern.

A good military explosive also must be capable of withstanding the shocks that are inherently incident to the loading and transportation of shells and to firing them from a weapon. It must be capable of detonating completely under the action of a comparatively small amount of booster or priming explosive, and upon complete detonation must reduce the shell to fragments fairly uniform in number and size. The average commercial high explosive such as nitroglycerin or dynamite would fail in these requirements and could not be used. Intensive research, based largely upon explosives suggested before the war, revealed the possibility of using explosives containing a considerable percentage of ammonium nitrate. One such was a mixture of ammonium nitrate, aluminum, and trinitrotoluene called ammonal. The French schneiderite consisted of a mixture of ammonium nitrate and dinitronaphthalene. Before these actually were adopted, England, in March 1915, put forward a mixture of ammonium nitrate and TNT which was called amatol.

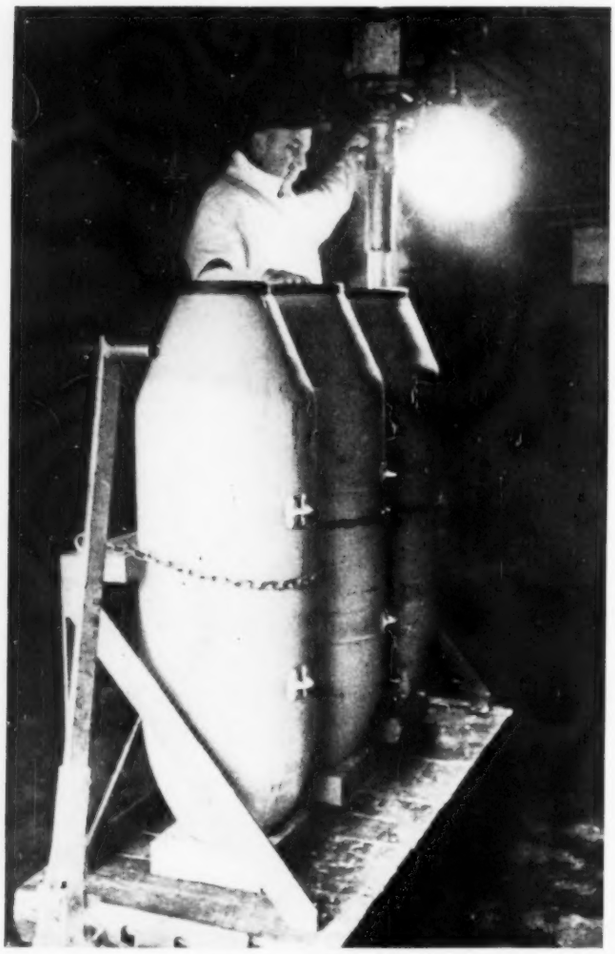
Ammonium nitrate alone is not considered an explosive under ordinary circumstances. Parenthetically, it may be said that not until the Oppau disaster in Germany in September 1921 when 500 people were killed and nearly 2,000 injured, had ammonium nitrate been known to explode without the admixture of some combustible. However, even in this case very special circumstances of high temperature, strong confinement, finely divided state and the use of a violent priming explosive prevailed. Mixed with from twenty to eighty per cent of TNT, however, ammonium nitrate becomes more powerful but slightly less brisant than either picric acid or TNT. The two mixtures most widely used were the one containing equal proportions, or 50-50 amatol, and the other which contained 80 per cent ammonium nitrate and 20 per cent TNT, or 80-20 amatol. The first of these mixtures can be melted and poured into shell and for this reason was used in larger-caliber shell; 80-20 amatol cannot be melted. It is loaded in a plastic state by being extruded into the shell by a specially designed extruding machine. This method of loading was limited to shell of about six inches' diameter.

POURING TNT INTO BOMBS TO FORM BOOSTER CAVITY

BY the time the United States entered the war, the need to make the available amounts of TNT extend as far as possible had been well demonstrated and acceptable methods established. It was found necessary, however, during the early stages of the war, to fill all shell with TNT regardless of cost until properly equipped plants could be built for mixing and loading amatol. Some difficulty was experienced. First, in order to overcome defects in the character of the ammonium nitrate produced in this country, so that proper densities could be obtained when mixed with TNT to form amatol, it was necessary to outline proper methods for the ammonium-nitrate manufacturers.

A product with sharp, hard crystals with a setting point of not less than 290 degrees Centigrade was found satisfactory. An experimental extruding machine was imported from England, but here again difficulty was overcome only after new and better-constructed machines were built for our own loading plants. Much credit is due these loading plants, and Picatinny Arsenal in particular, for the caliber of the experimental work which led to successful results. All difficulties of the operations were finally overcome so satisfactorily that the greater portion of the loaded shell was produced by this method.

The high explosives considered above were used largely for bombs and for high-explosive shell to be fired from minor- and medium-caliber guns and howitzers. Explosive D was continued in use in large-caliber shell of ten inches and above. For trench mortar and hand grenades, special explosives were developed. Since this type of ammunition had less extreme requirements than those types fired from a gun with the resulting large setback forces, it was possible to develop and use explosive mixtures using a nitrostarch base. These explosives were loaded into the shell or grenade



FILLING BOMBS WITH MOLTEN AMATOL

by light tamping or pressing which left them in a condition sufficiently sensitive to be brought to detonation by the standard fuze and detonator system. Their brisant effects were almost as high as those of TNT. To gain certain desirable advantages, other explosives have been adopted since the World War period to replace the war-time nitrostarch explosives.

All the high explosives previously mentioned are too insensitive to be detonated by a fuze detonator alone. For this reason, intermediate small charges of highly brisant explosives, called boosters, have to be used to take up the powerful localized shock of the fuze detonator and transmit it to the main bursting charge of the shell. Originally, crystalline picric acid and TNT were used for this purpose. In general, a crystalline material is much more sensitive than one in the cast condition. During the war, tetryl, which is trinitrophenylmethylnitramine, came into use to replace picric acid and TNT in boosters. While more expensive to manufacture than either of the latter, it is, however, more sensitive and hence more easily detonated; that is, it has a higher brisance and, therefore, greater initiating effect on the shell filler. Moreover it takes up the detonating wave from the initial detonating agent more easily and passes it along with greater effect upon the charge in the shell. In the densities of loading at which commonly used, tetryl has a rate of detonation of approximately 7,200 meters per second as compared to 6,800 meters per second for TNT.

In this country prior to the war, tetryl had not been manufactured but had been tested to some extent as a booster explosive. Since the war, considerable improvement in the manufacture and procedure for loading tetryl has resulted in much better quality of the material. In fact, as now manufactured and used, tetryl is substantially a chemically pure compound.

Owing to its high efficiency in causing detonation, it also has found extensive use in commercial explosives where it has partially replaced the mercury-fulminate–potassium-chlorate mixture formerly used. Many detonators for military fuzes contain tetryl together with mercury fulminate or other initiating agents. Tetryl has a melting point of 129 degrees Centigrade, is highly stable, nonhygroscopic and nonreactive with any metals used in military ammunition.

AS previously stated, the practicability of using the above-mentioned high explosives in military ammunition resulted from the important discovery by Nobel that mercury fulminate was more efficient in bringing about the detonation of high explosives than the black-powder fuses formerly used. Nobel's discovery resulted from his experiments made to obtain more reliable functioning of dynamite and blasting explosives being commercially produced by the Nobel Company. Literally hundreds of highly sensitive explosives, prepared in the course of research and development in organic chemistry, have been uncovered. It is of interest that this initial detonating explosive, discovered by Nobel, has maintained its position up to the present time. Practically every service during the war used mercury fulminate in the charge for fuze detonators.

Although mercury fulminate functions efficiently in bringing about detonations in high explosives, it has the weakness of being less stable than the other high explosives with which it is used and, for this reason, extensive research has been conducted over the years to obtain a more stable compound to replace it for both commercial and military uses.

BOMB PARTLY FILLED WITH 50-50 AMATOL

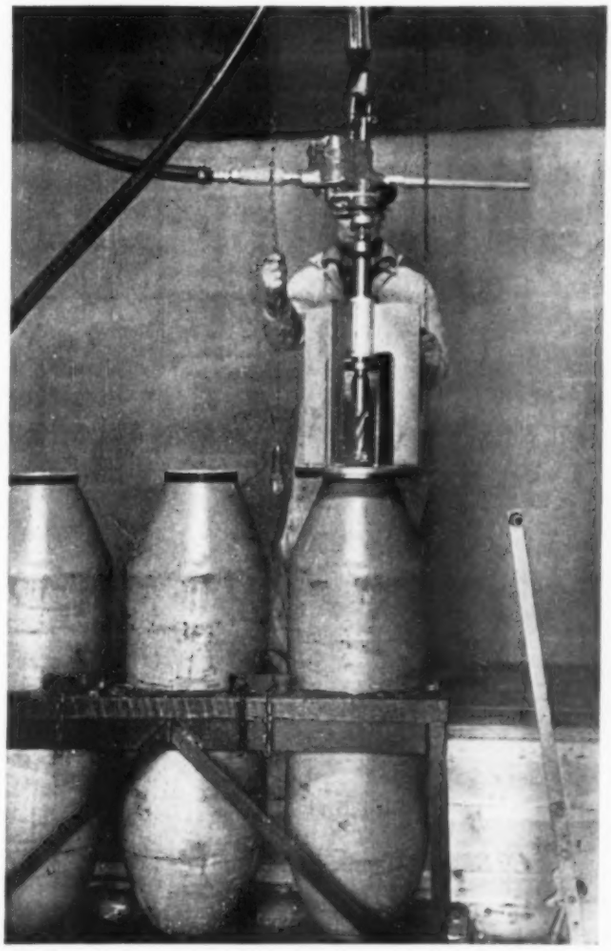
Some of the explosives which have replaced mercury fulminate to some extent are lead azide, diazodinitrophenol, hexanitromannite, and lead styphnate. Of these, lead azide

has largely replaced mercury fulminate for military use in various countries. While lead azide is somewhat more efficient as the initial detonating agent, its principal advantage over mercury fulminate is its markedly superior stability. Tests have indicated that its stability is of practically as high an order as that of TNT and other common nitro compounds, which means that it is able to withstand the normal conditions met with in storage over an indefinite period of time.

The early use of lead azide was impeded and hindered due to the fact that its sensitivity varied with crystal size and form. The larger crystals were so sensitive that they had been known to detonate upon the slightest handling. This is true also of the monoclinic or beta crystal form. Great care had to be taken to insure that small crystals of the orthorhombic or alpha form were produced. However, at the present time, methods of manufacture have been developed which consist essentially of precipitating the salt in the presence of a colloid of the dextrin type, the effect of which is to suppress crystal formation and produce spheroidal particles instead. The result is a free-flowing powder which is less apt to be detonated by mechanical impact than mercury fulminate. It is, however, sufficiently similar to mercury fulminate in its sensitivity so that practically the same methods of handling and loading can be followed.

THE position of the various countries varies widely with respect to availability of raw materials for the manufacture of the previously mentioned explosives. Due to the world-wide expansion in the facilities for fixation of atmospheric nitrogen and the manufacture of nitric acid by the ammonia-oxidation process, practically all the leading countries have the capacity to produce nitric and sulphuric acids required in the manufacture of high explosives. Most of the larger countries also have sufficient production of coal tar to meet their war-time needs, but none of them are equal to the chemical industry of the United States in these respects. In addition to the raw materials available in coal tar, such as phenol, toluene, benzene, etc., the enormous production of petroleum products in this country and the synthesis of phenol and other raw materials for explosives by special processes enable us to obtain raw materials greatly in excess of those that come from the coal-tar industry alone.

TNT DRILLINGS FROM BOOSTER CAVITY



DRILLING BOOSTER CAVITY WITH PNEUMATIC DRILL

Practically the only difficulty in obtaining an enormous production of high explosives in this country is the lack of sufficient plant facilities for converting the raw materials into the finished product. In spite of this lack of extensive facilities, all the explosives required for military use are in actual production in the United States, the processes for their manufacture in the quality required are well known, and personnel are available in the leading explosives-manufacturing organizations. Therefore, the difficulty narrows down merely to that of the time required to attain any additional production capacity.

EDITOR'S NOTE.—The above article is of particular interest at this time when the public print contains so many absurd claims and counterclaims regarding secret explosives of allegedly great power. In connection with Captain Dutton's article, we recommend that readers of ARMY ORDNANCE review another scholarly presentation on the same general subject which appeared in the September-October 1939 issue (Vol. XX, No. 116, page 91). The article is entitled "High Explosive Bombs—Debunking the Jargon that Makes the Headlines." The author is the distinguished chemist, Dr. Tenney L. Davis, of the staff of the Massachusetts Institute of Technology, Cambridge, Mass.

ARMY ORDNANCE

Published Bimonthly by
THE ARMY ORDNANCE ASSOCIATION
WASHINGTON, D. C.

MAY-JUNE, 1940

Month by Month

THE NONPOLITICAL CHARACTER OF ALL PARTS of the present national-defense program of the United States is at once a tribute to the integrity of the leadership of both major political parties. This happy condition has prevailed ever since rearmament was undertaken on a large scale three years ago and earlier when the replacement and augmentation of our naval forces got under way seven years ago. The people of the country may well take pride in the sagacity and prudence of leadership which has the rare good judgment of not trying to capitalize politically on any matter connected with the national defense. For the national defense is a duty of nationhood which transcends all political lines and surmounts all questions of party.

It is, therefore, with high commendation that the Hon. James W. Wadsworth of New York recently presented to the House of Representatives a statement on behalf of the entire Republican membership calling for adequate military strength. A similar statement was presented by Mr. Wadsworth last year and met with nation-wide approval. Nor was less to be expected in any civic cause with which Mr. Wadsworth is identified, for in truth his record for the national defense of the United States is second to none other of our national legislative leaders. It was he who carried the National Defense Act of 1920 to its final successful enactment. And in a more particular way it was he who sought and obtained the legislative mandate for industrial preparedness as it is written into that act.

Consequently the Wadsworth statement in 1940 recalls magnificent military victories begun nearly twenty-five years ago and bespeaks the same high purpose and integrity. We quote several pertinent paragraphs from the statement and commend them to all thoughtful citizens:

"So if we are to avoid that black picture of the complete loss of our democracy, our free institutions, our liberty, and our way of life, we must have a navy which is capable, at all times, of fending off any possible enemy. Far more important than that, we must realize that it is not mere defense that avoids aggression. This country could be rimmed with high-powered coast-defense guns—one every ten feet—and we would not defend this country at all without an adequate navy, because we must realize fundamentally that the enemy must be kept far off our shores. . . . If we are to avoid aggression, the world must know that we can retaliate in a greater measure of damage to any nation on earth than that nation can inflict upon us. Then, and then only, will they stay home and let us alone. No nation on earth need fear aggression on the part of the United States or invasion by us until we build a huge expeditionary army of millions of men with an enormous transport service. We have no such thing. We could not invade any nation without them, but we could inflict terrific damage if an invasion were attempted against us, if we have a proper navy.

"It is conceded we believe, that both the Army and Navy should be stronger if our military defense is to be adequate. We believe, further, that there would be little hesitation on the part of the Congress in adding very substantially to the present-day strength, especially in equipment, were it not for that circumstance which confronts us and which we must not ignore.

"The maintenance of our defense is linked with the maintenance of all other necessary activities of our Government. At the present juncture we cannot separate one from the other. The cost of the whole of them combined must be our concern as we strive to put our house in order. To put it simply, our plea is that the Congress, and others in high authority, reëstablish thrift as a virtue in the conduct of Government, as it is a virtue in the conduct of the individual."

IN A FAR DIFFERENT CATEGORY FROM THE above are the rather childish methods of inventors who claim revolutionary developments of secret death-dealing devices and who seize the national sounding board which a Congressional committee provides. Frequently these alleged devices relate to the field of ordnance. The customary practice in submitting military inventions for consideration by the Army and Navy of the United States is simple and fair. Simple and fair, that is, if you are willing to admit that it is presumptuous for either the inventor or the statesman to specify what our armed forces should have in the way of fighting equipment.

The War and Navy Departments are anxious at all times that citizens submit to them worth-while practical devices which may be used in connection with the national defense. The present wave of interest in things military has brought with it a tremendous surge of such suggestions, many of which are in theory not only not new but extremely antiquated. Many have rightly been described as "hokum." Some are good. Both Departments are quite willing to test any reasonable device which is submitted and at least to weigh the potentialities against whatever equipment the new device is to supplant or augment.

Thus it becomes quite silly when any inventor with veiled implications of blowing civilization to bits uses the technique of Mr. Barnum to advertise his brainchild. Equally humorous are those agrarian statesmen whose knowledge of things military is marked by its narrowness. We believe that the average citizen shares our faith, first, in the integrity of our professional defense officials who seek the best of armament

for our fighting forces and, secondly, in the ability of those officials over a long period of years to distinguish between what is next best and what is unsatisfactory in the entire field of arms, ammunition, and implements of war.

Therefore, when a showman comes to town with outlandish claims for his secret device which will blow an enemy to smithereens, a fair amount of skepticism is essential, pending further details. Not the most insignificant of these latter, as a rule, is the original purchase price and the unit price thereafter—whether an august legislative committee feels compelled to burn the minutes of their proceedings or not.

AMERICAN INDUSTRY NEEDS NO VOICE TO stress its loyalty to the national defense of our country. Industry's attitude of coöperation and achievement is an open book and sustains with each passing year the fine tradition which has existed so long between our manufacturing and engineering organizations, large and small, on the one hand, and the Army and Navy on the other. The record should contain all the recent statements of policy which have come from leaders of industry in support of the general attitude of our people that America keep out of this war. We select two of these not alone because of the purpose they express but for their inherent value to our national security.

The first is a statement from the annual report for 1939 of the president of E. I. du Pont de Nemours and Company: "In a recent address, the president of the National Association of Manufacturers said: 'American industry hates war. American industry wants peace.' The management of the Du Pont Company agrees with that view. Even apart from humanitarian considerations, which are paramount, it is the firm conviction of the management that war is an unmitigated evil, and that the present state of world affairs, in the long run, will be harmful to the company and to the whole of industrial life. For this company, as for all humanity, nothing could be more desired than a prompt, constructive settlement of the current wars on a basis giving reasonable assurance of permanent peace.

"At this time, a brief statement as to the company's present policy with respect to the manufacture of military products is desirable. In a communication to stockholders and employees, in September 1934, entitled 'The Du Pont Company and Munitions,' it was stated that the company in 1919 considered withdrawing completely from the production of military explosives but refrained from any action at the insistent request of the then Chief of Ordnance of the United States Army; and that such manufacture, though carried on in a small way during intervening years, has been negligible in relation to the volume of the company's peace-time products. Furthermore, since 1936, efforts to sell military explosives in foreign countries have been entirely discontinued.

"In recent months, as part of the general program of increased provision for the national defense, the company's production of military explosives for the United States Government has been increased somewhat, although resulting in no important expansion of the manufacturing capacity which remained after the drastic dismantlement and abandonment of plants of this character in 1919 following the World War. The company's services, in keeping with its policy over the years, will continue fully to be at the disposal of the United States Government in carrying out any further measures of protection.

"With respect to orders from foreign governments, the company has no available plant facilities with which to execute such orders in any important volume. Volume production of military explosives for such purposes has not been and is not now being sought. The management feels it is not justified in risking the company's capital for such a purpose. Any future developments will be dictated by world conditions and the needs of this nation."

The second statement is from the annual report of Eugene G. Grace, president of the Bethlehem Steel Corporation: "Your management believes that the interests of your corporation will best be served by conditions of peace rather than of war. After the close of the World War, your corporation discontinued production of munitions and gradually developed commercial lines of products to utilize its facilities, retaining, however, some facilities for producing armor plate and forgings for guns, shells, etc., for the United States Government. Your management believes that under present conditions it is not wise to invest the capital of your corporation in additional facilities for the production of munitions or to use its present facilities for that purpose at the expense of its commercial business."

Many other statements in similar vein could be quoted. These, however, should be sufficient to show that those parlor pinks who say that industry wants war are frauds.

THOSE GENTLEMEN WHO SERVE THE CAUSE of industrial preparedness as officials of the Ordnance districts are well known for the disinterestedness of their patriotic service. Many of them are nationally known leaders in industry and the professions. Some have served with high distinction in war as well as in peace. To their judgment and unfailing guidance is due the exceptionally meritorious state which the industrial aspects of our military armament preparedness have reached today. It is safe to say that in the fruition of many ideas and ideals which has come about in the present stage of unrest throughout the world, none can bring greater assurance to the continued peace of the United States than the work which has been done by the fourteen Ordnance procurement districts.

But when there appears among this distinguished group an author whose words of wisdom rival those of his distinguished namesake, the national defense in general and the Ordnance part of it in particular have ground for added enthusiasm! There recently has come from the press a little volume of 180 pages entitled "Banners in the Wind." Its author is Col. Benjamin A. Franklin, chief of the Hartford Ordnance District and well-known leader of the Ordnance cause throughout the entire Connecticut Valley. This is another "Poore Richard's Almanac," written against the background of the twentieth century rather than the eighteenth. It is a personal philosophy as sound as Poore Richard's but geared to modern tempo in style and manner.

This book, which is of particular meaning to the Ordnance fraternity, has a deeper message for all of us. For Colonel Franklin hammers away for those characteristics of discipline, integrity, and prudence which are synonymous with military efficiency. Little wonder that ordnance preparedness flourishes when it has such men among its sponsors.

Production Studies

An Editorial

PRODUCTION studies for the manufacture of ordnance in time of war are now a reality. The Ordnance Department of the Army has embarked upon a program which is designed to increase the defense potential of many of the principal manufacturers to whom war-time allocations of noncommercial items of armament have been assigned. The implications of these studies in the light of the current program of educational orders are of extraordinary significance. When production studies and educational orders are viewed as auxiliary to the current ordnance production program, there is every warrant for the firm assertion that never has our industrial preparedness attained so high a state of efficiency as at present. For the attack upon our ordnance problem is under way on four fronts: current production, educational orders, critical materials, and production studies.

Elsewhere in this issue the current production program and the educational-orders program are described at length by the two officers of our Army best qualified to do so. Since his is the responsibility for the production program, the analysis by Maj. Gen. C. M. Wesson, Chief of Ordnance of the Army, is of special moment. It is his statement to the War Department Subcommittee of the Appropriations Committee of the House of Representatives and was made by him when the estimates of expenditures for the coming fiscal year were presented to the Congress in March 1940. General Wesson's presentation has a unique feature which is more characteristic of procedure in the British Government than in our own. It is customary in England for heads of governmental departments not only to present their future plans but also to account for their past performance. This is an admirable policy and is all too rare in our practice. General Wesson's statement is as much in the nature of an accounting of his stewardship as it is of plans for the coming year. In purpose, as well as in content, it is a document which well deserves the perusal of every taxpayer. Its simplicity and candor as well as its narrative of a fine record of performance give ground for pride in the work that has been done and confidence in that which remains to be done.

The program of educational orders rightfully is controlled by the Assistant Secretary of War, although the actual operation is conducted by the supply arms and services of the Army. As Chief of the Planning Branch in the Office of the Assistant Secretary of War, Col. H. K. Rutherford is responsible for the general administration of this program. His article in this issue is also a timely and thought-provoking statement of the progress of the educational-orders program for the current year. Here is a progress report which reflects credit upon the supply arms and services—the Ordnance Department, as the tabulation on page 370 shows, having the most extensive portion of that program.

Not only must the current status of educational orders be available from time to time to all students of industrial preparedness, but the record—complete, unabridged and self-explanatory—must be available at all times. In the years to come there must be no possibility that any interested citizen will not be able to follow each successive step in this very vital history. This must be as well for the objective value of the record as for the disillusionment of short-memoried critics who may try to misinterpret it sometime in the future.

Mention also should be made of the progress which is taking place in the accumulation of stock piles of critical materials for national-defense purposes. This program is likewise progressing satisfactorily, and, if further funds which have been authorized by the Congress are appropriated, there is every reason to believe that the accumulation of protective quantities of these materials in peace-time storage for war-time use will be a boon to the production of armament if a major war should ever come to us again.

THESE three components of the present all-inclusive rearmament activities have been sought for many years. A production program is now a reality; an educational-orders program is now in operation; a reserve of critical materials is now being accumulated. But even before any of these methods of preparedness was urged in military and industrial circles, production studies were being thought about and planned. In the earliest days of postwar industrial-mobilization thinking, Maj. Gen. C. C. Williams, Chief of Ordnance, and his assistant, Brig. Gen. C. L'H. Ruggles (then Chief of Manufacture in the Ordnance Department), favored production studies as being a practical solution to the then apparently hopeless requests for educational orders. For production studies were thought to be—as indeed they are—a most valuable but relatively inexpensive process of industrial-mobilization planning. Valuable far beyond the small financial cost, they are to be measured in terms of knowledge acquired. It is safe to say that if every major industrial organization in the United States to whom the Army and Navy must look in time of war for quantity production of armament and its components would periodically, in time of peace, prepare a production study, then the dead time between the beginning of an emergency and maximum production would be reduced ten per cent.

The general objective of the production study is to prepare a manufacturing analysis of war-time production of a particular item at a maximum rate in a particular plant. In the preparation of such a study the contractor will require and undoubtedly will receive such assistance as the War Department may have at its command. Thus it is reasonable to expect that shop, jig, fixture, and manufacturing-gage drawings, when available, will be loaned to the contractor. On the basis of drawings and specifications and of finished parts, where available, the particular objective of the study will be to determine (1) all the operations necessary to the performance of the work, (2) the most advantageous sequence of operations, (3) the most appropriate machines on which the work is to be done to insure early production, and (4) the adaptation of each of the previous steps to the kind and quantity of the particular equipment owned or to be procured by the company.

It is to be hoped that as these production studies proceed both industry and the War Department will find common ground where collateral problems of war-time manufacture will be solved and where our military designs themselves will be benefited by even wider familiarity on the part of civilian production engineers.

L. A. C.

Association Affairs

DIRECTORS' MEETING

THE twenty-first annual meeting of the trustees and directors of the Army Ordnance Association was held at the Metropolitan Club, New York City, on February 28, 1940. The meeting was called to order at two o'clock in the afternoon by Brig. Gen. Benedict Crowell, president of the Association, who presided. Maj. Gen. C. M. Wesson, Chief of Ordnance, United States Army, was the honor guest at the meeting and at luncheon which preceded it. The following officers and directors were present: Col. Frederick H. Payne, vice-president; Col. Robert P. Lamont, director; Col. Frank A. Scott, director; Brig. Gen. Samuel McRoberts, director; Col. James L. Walsh, director; Mr. W. C. Dickerman, director; Brig. Gen. John Ross Delafield, counsel; Brig. Gen. Chas. Elliot Warren, treasurer, and Lieut. Col. L. A. Codd, executive secretary. By invitation of the president, Col. Thomas F. Brown, assistant chief, New York Ordnance District, and Col. J. K. Clement, executive officer, New York Ordnance District, also were present.

The president extended special greetings to General Wesson. "One of the best indications," he said, "of General Wesson's loyalty to our society is his presence here today. He is standing by to appear at a moment's notice before the Appropriations Committee of the House of Representatives to present another historic ordnance program—the program for the coming year. Yet, at great personal sacrifice he has made the journey from Washington. I know that all of you join me in a very sincere tribute to him for his great work and for this latest evidence of his interest in our society."

General Wesson responded by thanking General Crowell and all officers and directors of the Association for the work that has been done for industrial preparedness under the auspices of the Army Ordnance Association. He emphasized the close relationship which has existed between the Ordnance Department and the Association for more than twenty years and expressed the hope that it would long continue for the advancement of our armament preparedness.

General Crowell also greeted Colonel Brown and Colonel Clement and invited them to participate in the deliberations.

The president also extended special greetings to William C. Dickerman, a new member of the board, representing the New York Post. "All of us have known Mr. Dickerman for many years," he said, "as an outstanding leader of American industry. He is head of the American Locomotive Company and it is a particular honor to have him, a charter member of our society, serve as a member of our board." Mr. Dickerman responded by expressing his admiration for the work of the Army Ordnance Association and his pleasure in becoming a member of the board.

The president also announced the election to the board of Col. Herbert A. Gidney, representing the Pittsburgh Post; George W. Elliott, representing the Philadelphia Post; Earl B. Gilmore, representing the Los Angeles Post, and L. W. Scott Alter, representing the Cincinnati Post.

The president also announced that Maj. Gen. William Crozier, Chief of Ordnance of the Army, 1902-1918, who had been invited to attend the meeting, was unavoidably detained in Washington. Col. William W. Coleman, of Milwaukee, vice-president of the Association, also was unavoidably detained as was Maj. Gen. C. C. Williams, of South Hamilton, Mass., Chief of Ordnance, 1918-1930. The secretary was instructed to send telegrams of special greeting to Generals Crozier and Williams and to Colonel Coleman.

The first business to come before the meeting was the report of the treasurer for the year 1939. General Warren submitted his detailed report analyzing the financial operations of the Association for the calendar year. Receipts were $34,979.02; expenditures were $33,711.19. The excess of operating receipts over operating disbursements was $1,297.21. Cash on hand as of December 31, 1939, was $3,100.66; securities owned as of that date had market value of $25,949.09. The balance sheet disclosed an operating reserve of $13,209.06.

The treasurer announced that the annual audit of the financial records of the Association had been made by Ernst & Ernst, certified public accountants, as of December 31, 1939. Copies of the audit report were available at the meeting. The treasurer's report was accepted with thanks and approved. A motion also was unanimously adopted thanking General Warren for his services to the Association as its treasurer since its foundation in 1919. The next order of business was the annual report of the executive secretary. A résumé of the report is published below.

The treasurer's report showed the following principal tabulations:

RECEIPTS AND EXPENDITURES

Receipts	*1939*	*1938*
Old members	$ 8,514.30	$ 7,184.62
Old group members	4,400.00	4,300.00
New members	6,051.52	2,262.05
New group members	2,900.00	400.00
Interest	1,078.75	1,100.13
Old subscribers	1,807.12	1,726.48
New subscribers	1,006.40	1,108.13
Advertising	8,606.17	6,027.90
Miscellaneous	514.76	279.48
Life members	100.00	0.00
Total	$34,979.02	$24,388.79

Expenditures	*1939*	*1938*
Rent	$ 1,309.50	$ 1,110.00
Office expense	2,338.76	1,172.05
Salaries	12,901.68	11,835.00
Postage	1,270.52	840.26
Annual Meeting	533.81	298.29
Office equipment	389.45	0.00
Extension	1,455.51	710.31
Post refunds	936.47	490.75
Contingencies	945.53	495.07
ARMY ORDNANCE	11,549.34	8,094.13
Taxes and insurance	51.24	0.00
Transfer to investment account	29.38	0.00
Total	$33,711.19	$25,045.86

The president described the outstanding work of Col. Frederick H. Payne as chairman of the Association's Committee of Three Hundred on Twentieth Anniversary. Throughout the year 1939 Colonel Payne directed the general activities of the Association toward increased membership. As a result of the work of his committee, the Association had the largest growth in any one year since its foundation in 1919. Nineteen hundred and seventeen new members were enrolled and there was a net gain in membership of 1,618.

As a mark of the Association's gratitude to Colonel Payne for his personal leadership of this cause, General Crowell proposed, with the concurrence of the board, that special honors be tendered him at this meeting. As a fitting expression of thanks, General Crowell proposed that honorary life membership be conferred upon Colonel Payne. This proposal was unanimously and enthusiastically adopted. Accordingly, General Crowell presented to Colonel Payne a scroll conferring honorary life membership upon him and thanked him personally for his service.

Colonel Payne responded by thanking the president and the members of the board. He expressed his enjoyment of the assignment during the twentieth anniversary year and expressed the hope that membership would continue to increase. In this and all

other activities he pledged his continued active participation.

The chairman suggested a vote of thanks to General Warren who made available the facilities of the Metropolitan Club where this meeting was held and who arranged the luncheon which preceded the meeting. The motion was enthusiastically adopted.

EXCERPTS from the annual report of the executive secretary as submitted to the board follow:

The total membership of the Association as of January 1, 1939, was 3,065. During the year 1,917 new members were enrolled while 299 old members were removed from the roster through resignation, death, and nonpayment of dues. The number of members in arrears was 675 of whom 61 were in arrears for more than 6 months.

The following budget of receipts and expenditures for the year 1940 was submitted:

Receipts		*Expenditures*	
Old members	$12,500	Office rent	$ 1,530
Old group members	6,800	Office expense	2,000
New members	4,000	Salaries	14,000
New group members	2,000	Postage	1,500
Magazine subscriptions, renewal	2,000	Annual meeting	1,000
		Office equipment	500
Magazine subscriptions, new	1,360	Post refunds	1,200
		Contingencies	1,200
Advertising	12,000	Membership extension	1,500
Interest	1,040	ARMY ORDNANCE	14,500
		Year book	1,770
Total expected income for 1940,	$41,700	Total recommended expenditures	$40,700

During the year 29 new group members were enrolled and 2 old group members were dropped from the roster. There are 76 group members in good standing. One new life member was enrolled during the year. There are now 21 life members enrolled.

During the year the Lehigh-Bethlehem Post was established with a membership of 59. The Post's charter was presented on behalf of the president by the executive secretary at ceremonies held at Lehigh University on November 15, 1939. There are now 15 chartered posts. The total number of members affiliated with these local posts is 3,287, or 70.1 per cent of the total Association membership. During the year the policy was continued of automatically assigning new members to membership in the post in whose territory the member resides.

The Twentieth Annual Meeting of the Association was held in Washington on October 11, 1939, and, by invitation of General Wesson, at the Aberdeen Proving Ground, Md., on October 12th. The sessions in Washington met with enthusiastic response. Six hundred and ten members and guests attended the industrial-preparedness luncheon and the industrial-preparedness round table which followed. Seven hundred and seventy places were reserved for the Twentieth Anniversary Dinner. The addresses at these functions were historic in character by reason of their timeliness, importance, and content.

At the Aberdeen Proving Ground sessions on October 12th a program of demonstrations was presented which, in the judgment of those who had attended Ordnance Day during twenty years, had not been exceeded for interest and effectiveness. Some 5,000 members and guests were in attendance. Box luncheons were served to 1,980. The Association is under a renewed debt of gratitude to General Wesson and the officers of his staff; to Col. J. B. Rose, commanding officer of the Aberdeen Proving Ground, and especially to Col. Burton O. Lewis, of the Proving Ground staff, who was in charge of the Aberdeen program.

Coming in the twentieth anniversary year when world conditions have proved so conclusively the soundness of industrial preparedness, for which the Army Ordnance Association has stood unfalteringly since 1919, this meeting marked a milestone of preparedness progress. During the year throughout the country other meetings on a similar scale and under similar auspices have testified to the general interest and desire to coöperate in our preparedness undertakings. Thus, meetings of exceptional size and importance were held in Chicago, Milwaukee, Cincinnati, Boston, Los Angeles, St. Louis, Buffalo, Pittsburgh, San Francisco, and Hartford. All these gatherings have been fully described in ARMY ORDNANCE during the year.

By direction of the president and trustees, a Committee of Three Hundred on Twentieth Anniversary of the Association was appointed in the fall of 1938. Col. Frederick H. Payne, vice-president of the Association, assumed the chairmanship of this committee. With Colonel Payne's constant help, the committee succeeded in increasing the membership of the Association far beyond any previous total.

The executive secretary's annual report concluded as follows:

"It will be noted from the above, and especially from the plans indicated by the proposed budget for 1940, that continued expansion both in membership and in service is planned. World events, our own armament program, and a reawakened interest on the part of the American people in the stability of our armament preparedness, indicate a continuing healthy growth of the Army Ordnance Association.

"In conclusion, the executive secretary expresses his thanks to all officers and directors for their unfailing confidence and support. In particular, and with depth of feeling, he acknowledges the constant coöperation of General Crowell, president of the Association, and General Wesson, Chief of Ordnance of the Army. In like manner the helpful interest of all officers and directors is a continuing element of the Association's strength. In the spirit and hope that these will continue unabated, the Army Ordnance Association, as an acknowledged leader of industrial preparedness in our country, can face confidently the growing obligations which, because it has fostered them, now depend upon it for their vindication."

The balance sheet of the Association showed the following assets and liabilities:

Assets	*1939*	*1938*
Cash on hand	$ 20.00	$ 544.80
Cash on deposit	3,080.66	1,288.03
Accounts receivable:		
Due from advertisers	483.73	50.00
Other assets:		
Securities owned	24,557.82	24,051.25
Postage	122.75	174.24
Furniture and fixtures	1.00	1.00
Deferred charges:		
Commission on prepaid advertising	144.90	144.90
Total	$28,410.86	$26,254.23

Liabilities	*1939*	*1938*
Unearned income:		
Prepaid membership dues	$11,152.55	$ 6,558.55
Prepaid subscriptions to magazine	774.75	987.00
Prepaid advertising	352.00	378.10
Reserves:		
Endowment fund	822.50	822.50
Life memberships	2,100.00	2,100.00
Operating reserve	13,209.06	15,408.08
Total	$28,410.86	$26,254.23

GEORGE W. ELLIOTT ELECTED TO DIRECTORSHIP

GEORGE W. ELLIOTT, vice-president of the Philadelphia Post and general secretary of the Philadelphia Chamber of Commerce, has been elected to membership on the national board of directors of the Army Ordnance Association representing the Philadelphia chapter. Mr. Elliott long has been identified with the civic and industrial life of his city. He served as director of public safety there prior to his affiliation with the Philadelphia Chamber of Commerce in 1928. He is president of the Boy Council of Philadelphia, vice-president of the Crime Pre-

vention Association of that city, and a member of the executive committee of the National Safety Council. His interest in Ordnance affairs has been closely identified with the Philadelphia Ordnance District under the leadership of Philip H. Gadsden, the district chief. He is a welcome and valued addition to the board of directors of the national society.

NEW ASSISTANT CHIEFS OF DETROIT ORDNANCE DISTRICT

ALEX DOW, chief of the Detroit Ordnance District, has nominated, and the Chief of Ordnance has confirmed the appointments of, two gentlemen who will serve as assistant chiefs of the Detroit district. Frank W. Steere, president of the Pontiac Chamber of Commerce, Pontiac, Mich., and William B. Hurley, an engineer of the Detroit Edison Company, are the new appointees. Both are welcome additions to the small but important group of civilian leaders who are rendering such self-sacrificing and highly valued service to industrial preparedness in the capacities of chiefs, assistant chiefs, and members of advisory boards of the fourteen Ordnance districts throughout the country.

LOS ANGELES POST

THE Ordnance stalwarts of Southern California, five hundred strong, led by Earl B. Gilmore, president of the Los Angeles Post, Army Ordnance Association, held their annual Ordnance Day at Fort MacArthur, San Pedro, Calif., on Sunday, March 31st. Col. E. A. Stockton, Jr., C.A.C., commanding officer at Fort MacArthur, directed a day of demonstrations and exhibits which rivaled Ordnance Day as it has been observed at the Aberdeen Proving Ground for so many years. Maj. Ralph Cook Scott, secretary of the Post, was in general charge of arrangements. Every detail of the meeting reflected great credit upon the ability and zeal of Colonel Stockton and the officers and men of his command and upon the leadership and energy of Mr. Gilmore and Major Scott.

The meeting brought to a climax a 2-day session which started on the evening of March 29th with the annual dinner meeting of the Post at the Los Angeles Athletic Club. At this meeting several hundred members of the Post were present to hear the addresses given by Max A. Koffman, vice-president of the Los Angeles Chamber of Commerce, and Lieut. Col. L. A. Codd, Ord. Res., editor of ARMY ORDNANCE. Mr. Gilmore presided.

In his address, Mr. Koffman described the vast industrial resources of the Los Angeles area, particularly in terms of those industries which are closely related to the national defense. Already this region has demonstrated its close relationship to ordnance progress and industrial preparedness as evidenced by the production and educational orders which are under way in Los Angeles. In this city is located a regional Ordnance procurement office—known as the Los Angeles Ordnance Region—with its headquarters staffed by an executive officer and several civilian engineers and secretaries. Mr. Koffman assured the members of the defense forces who were present that Southern California stands ready with its entire man power and manufacturing power to aid the industrial-preparedness cause to the very maximum of its ability.

Colonel Codd spoke on the subject, "The Essentials of Modern Industrial Preparedness for Our National Defense." He described the progress which has been made in the field of industrial-mobilization planning.

"The four essentials of modern ordnance preparedness," he said, "are included in the four types of activity which are now under way. The first of these is the production order under which the War Department is procuring the weapons, ammunition, and other equipment needed by our Regular Army, National Guard, and Reserve forces. The second essential is the educational order. Educational orders are training orders given to private industry for the production of noncommercial items of military equipment. Progress has been made in allotting orders to those industries upon which we must depend in time of war to manufacture our military armament.

"The third factor is an adequate supply of strategic and critical raw materials. While the United States is practically self-sufficient, we do lack certain commodities without which our armament program in peace and in war could be seriously jeopardized. The Army is now accumulating small reserves of some of these items for future use.

"The fourth factor in modern ordnance preparedness is the production study by which selected companies are trained in the analysis of war-time production difficulties so that in the event of a major emergency they can the more quickly and more expeditiously undertake any war-time assignment.

"But these are not new ideas," Colonel Codd said. "They have been sponsored and urged by the Army Ordnance Association for many years. Fortunately the people of the United States today—by realization of world conditions—have come to see the necessity and logic of such enterprises.

"Industry in Los Angeles is coöperating splendidly in the program, and the fine efforts of Mr. Gilmore and his associates of the Los Angeles chapter of the Association have been of tremendous help in bringing about a proper realization of the importance of these factors of our national defense."

Others at the speakers' table, in addition to Mr. Gilmore, Colonel Stockton, Mr. Koffman, Colonel Codd and Major Scott, were: Col. Rush B. Lincoln, A.C., commanding officer, March Field; Col. Halsey E. Yates, Inf., executive officer of the Southern California Military District, in charge of all Reserve-officer activities in Southern California; Col. R. W. Pinger, Ord. Dept., Ordnance officer of the Ninth Corps Area; Lieut. Col. H. V. Hopkins, A.C., March Field; Maj. George D. Hamilton, U.S.M.C., officer in charge of Marine Reserve activities in Southern California; Maj. Thomas M. Jervey, Ord. Dept., Ordnance officer, March Field, and Maj. A. R. Baird, Ord. Dept., executive assistant of the Los Angeles Ordnance Region.

The program at Fort MacArthur began at 10 A. M. with firings of 3-inch antiaircraft guns against towed targets. All firings and demonstrations throughout the day were conducted by the 63rd Regiment of Coast Artillery (Antiaircraft) stationed at Fort MacArthur. Several courses were flown and remarkably accurate results were obtained. Following this and all other demonstrations, those present (admission was by invitation only) were permitted to inspect the equipment. This was followed by a splendid exhibition of machine-gun firing against an aircraft target. Caliber .50 and caliber .30 antiaircraft machine guns were used. Next the visitors were taken to various locations on the upper reservation for inspection of seacoast fortifications and 155-mm. G.P.F. guns.

Luncheon was served at 12:15. Guests were comfortably seated in the mess halls of the barracks for a delicious dinner, prepared and served by the personnel of the 63rd Coast Artillery.

The afternoon program was held at the lower reservation. At 1:30 P. M. there was a drill and inspection of 14-inch railway artillery—the most powerful guns of their type in the U. S. Army. Following this, visitors were conducted through a most complete display of ordnance equipment arranged around the parade ground. Included in the display were antiaircraft machine guns, antiaircraft artillery, fire-control and searchlight equipment. There was an instructive display of aviation ordnance from March Field, an interesting exhibit of small arms, and a complete group of antiaircraft transportation, repair and wrecker vehicles.

The program concluded with a parade of the 63rd Coast Artillery Regiment, at which the reviewing officer, Colonel Stockton, was accompanied by Mr. Gilmore, Colonel Codd, and Major Baird.

At the close of the program, the hundreds who had come not only from Los Angeles but from other cities of Southern

California, were loud in their praise of the inspiring program arranged by Colonel Stockton and so ably presented by the officers and men of his command. The educational value of the exhibits gave further proof that industrial preparedness is a vital force for our national security in Southern California in as great a degree as in other sections of the country.

The Los Angeles chapter of the Army Ordnance Association was formed May 27, 1936, and has a membership of nearly two hundred. Its officers and directors are: Mr. Gilmore, president; Mr. Donald Douglas, vice-president; Col. W. H. Adams, Lieut. Col. Ralph O. Cragin, Lieut. Col. M. M. Mitchell, Mr. H. S. Hitchcock, Mr. F. B. Cole, and Mr. Koffman, directors; Capt. Samuel K. Rindge, treasurer, and Major Scott, secretary.

Lehigh-Bethlehem Post

BRIG. GEN. C. T. HARRIS, JR., Assistant to the Chief of Ordnance and chief of the Industrial Service of the Ordnance Department, was the principal speaker at the regular meeting of the Lehigh-Bethlehem Post of the Association on the evening of March 13, 1940. The meeting was held at the Bethlehem Club and was attended by a large representation from the student body and from the various industries in and around Bethlehem. E. G. Uhl, Lehigh '41, president of the chapter, presided. Dr. C. C. Williams, president of the university, was an honor guest.

Speaking on the ordnance problem, General Harris presented a comprehensive review of the various factors involved and stressed the time element required in the transition of American industry from a peace to a war footing in the event of a major emergency. In appraising the magnitude of the problem, General Harris spoke highly of the industrial concerns in the Bethlehem area which have such an important rôle in our national defense. He paid tribute to American industry in general for the effective way in which it is coöperating with the Ordnance Department on the present armament program and cited figures showing the remarkable progress which has been made in carrying out this program. He described the steps which are being taken in placing educational orders for ordnance production and also the program of production studies which is now under way with private commercial plants. He congratulated the members of the Post which is unique among chapters of the Army Ordnance Association in that it combines student and industrial memberships.

President Williams greeted General Harris and other visitors who included Lieut. Comdr. G. D. Linke, naval inspector of ordnance at Bethlehem; Col. J. S. Leonard, head of the department of military science and tactics at the university; Col. C. C. Curtis, commanding officer of the 213th Regiment of Coast Artillery; Lieut. Col. L. C. Atwood, executive officer of the regiment; Lieut. Col. J. A. Hall, 314th Infantry Regiment, Organized Reserves; Lieut. Col. L. A. Codd, editor of ARMY ORDNANCE; Capt. B. S. Mesick, founder of the Lehigh-Bethlehem Post, who is in charge of the Ordnance Unit, R.O.T.C., at Lehigh, and Capt. W. S. Broberg, representing the Philadelphia Ordnance District. Robert Caemmerer, Lehigh '41, a member of the executive committee of the chapter, was chairman of the committee on arrangements.

Preceding the meeting, General Harris visited the university's department of military science and tactics and also the Bethlehem Steel Company's plant at Bethlehem.

M.I.T. Post

THE regular monthly meeting of the Massachusetts Institute of Technology Post, held March 7th, had as its principal speaker Prof. Tenney L. Davis of the Institute faculty. Doctor Davis, who is an acknowledged authority on powder and explosives, spoke on "High Explosive Bombs in Modern Warfare." He discussed the chemistry of the more important explosives as well as the uses of bombs. Following the lecture, Doctor Davis answered questions from members. The meeting was well attended not only by the student membership but by many Regular and Reserve Ordnance officers.

The Post has scheduled for its April meeting a visit to the 101st Ordnance Company, Massachusetts National Guard. This organization, which is a medium maintenance company with a high record of efficiency, will present a demonstration of its equipment.

Retirement of Colonel Jordan

COL. HARRY B. JORDAN, well-known officer of the Ordnance Department, retired from active military service February 29, 1940, having reached the statutory retirement age. In relinquishing his active duties, Colonel Jordan completed a military career of distinction. His most recent tour of duty as commanding officer of the Nansemond Ordnance Depot and his preceding assignment as director of the Army Industrial College were notable periods in a record of service begun upon his appointment to the United States Military Academy from which he was graduated in 1901. He also was graduated from the Army War College, 1925; the Army Industrial College, 1926, and the Command and General Staff School, 1927.

Beginning his military career as a second lieutenant of Cavalry, Colonel Jordan was detailed to the Ordnance Department in 1903, embarking upon a long period of service at arsenals and depots culminating in his service overseas with the American Expeditionary Forces. He was among the first Ordnance officers to serve in France where he took active part in the organization required for the supply of ordnance equipment to the A.E.F. and the Allies. He returned to this country to assume the important post of commanding officer of the Rock Island Arsenal and directed the program of completing there the famous British Mark VIII tanks which were then under manufacture.

Colonel Jordan's greatest success, however, came during the four years he served as director of the Army Industrial College. He continued the high standards of that school and broadened its curriculum. The college, during his tenure, grew in numbers and esteem, bringing it to a par in importance and scope with the other service schools of the Army and Navy.

Colonel Jordan was a frequent contributor to the pages of this journal, thus adding to his host of friends in American industrial and economic pursuits. These will join with the many charter members of the Army Ordnance Association in extending to him the congratulations which are his due for an outstanding military record and their wishes for many happy years.

Gage Laboratory at the University of Cincinnati

THE sixth in a series of gage laboratories being established by the Ordnance Department at universities located in important manufacturing centers was formally opened at the University of Cincinnati on January 19, 1940. Formal presentation of the laboratory to the university had been made by Maj. Gen. C. M. Wesson, Chief of Ordnance, on the occasion of his visit to Cincinnati early last summer. During the succeeding months, appropriate space was prepared in the basic science laboratory, and the gage-checking equipment was shipped and installed. E. A. Muller, chief of the Cincinnati Ordnance District, turned over the completed installation to President Raymond Walters with remarks appropriate to the occasion. President Walters replied in a brief address, in which he pointed out how gladly the University of Cincinnati undertook the custody of the laboratory which was to be used for the benefit of students, manufacturers, and the Ordnance Department.

After the formal opening, the laboratory was inspected by faculty members, students, manufacturers representatives, and Reserve officers. The following day, L. W. Dwyer, chief gage

designer of Watervliet Arsenal, was present and served as an instructor in the use of the equipment to faculty members, students, Reserve officers, and the personnel of the Cincinnati Ordnance District Office. Previously, Mr. Dwyer had presented an illustrated talk before members of the Army Ordnance Association and the Reserve officers of the district on "The Basic Principles of Interchangeable Manufacture." This interesting address was followed by a discussion period.

The laboratory equipment includes precision blocks, sine bars, micrometers, and the usual supply of small but important items of equipment. Among the larger units are a P. & W. supermicrometer, a Taft-Pierce 36-inch bench center, screw thread comparators, toolmakers' microscope and a P. & W. measuring machine of 4-foot capacity. Valuable additions are two modern visual gages furnished through the courtesy of the Sheffield Gage Corporation.

Maj. F. A. McMahon, executive officer of the Cincinnati Ordnance District, supervised the installation of the laboratory, and Dr. Walter Soller, director of the basic science laboratory of the University of Cincinnati is in charge. The university plans to establish courses of instruction in the use and checking of gages at an early date.

INSIGNIA AND SERVICES

ALL members of the Army Ordnance Association should be familiar with the various insignia and services that may be obtained at nominal cost through the Executive Offices of the society at 806 Mills Building, Washington, D. C.

The medal of the Association is the principal emblem for wear with military uniform. Struck from bronze taken from a captured German cannon, it consists of the coat of arms of the Association suspended from a ribbon of grosgrain silk in the Association's colors—crimson, yellow, piped in black. A miniature medal, bar ribbon, civilian pin in bronze or gold, and a lapel bar also are available.

A wall plaque of the Association's seal in art plaster, 8 by 9 inches, colored in crimson and bronze, likewise may be obtained by members. The plaque makes a particularly effective decoration in office or library.

Many readers of ARMY ORDNANCE have saved their copies from year to year until they have built up what is considered to be the only complete library of authentic information on the armament of the United States. The Association now offers a binding service to those who wish to preserve their set of ARMY ORDNANCE in a more permanent form. Copies are bound, six issues to the volume, in three-quarters maroon calf or in maroon buckram.

In response to requests, the Association now has available a membership certificate, 14¼ by 9 inches, suitable for framing. The certificate will be engrossed with the member's name. Write to the above address for prices or further information.

NEW MEMBERS

DURING the period February 1, 1940, to March 31, 1940, inclusive, the following applicants were admitted to membership in the Army Ordnance Association: Gale L. Adams, San Marino, Calif.; M. Albertson, Houston, Tex.; Arthur B. Allison, Montgomery County, Pa.; Daniel W. Allison, Long Beach, Calif.; John B. R. Anderson, Pittsburgh, Pa.; Wm. W. Anderson, Providence, R. I.; Paul E. Atwood, Kingsport, Tenn.

Thaddeus F. Baily, Canton, Ohio; Glenn J. Baker, Shreveport, La.; W. E. Baker, Evansville, Ind.; William W. Baker, Cincinnati, Ohio; Leland Chandler Ball, Cincinnati, Ohio; A. G. Ballenberg, Chicago, Ill.; Charles E. Balough, Canton, Ohio; Edmond G. Barbier, Woodside, N. Y.; William H. Bassett, Jr., Scarsdale, N. Y.; Robert F. Baum, Cincinnati, Ohio; Lloyd E. Beach, Wilmette, Ill.; B. L. Benbow, Euclid, Ohio; Allen P. Blade, Arlington, Va.; Harry P. Blake, Canton, Ohio; Edgar S. Bloom, New York, N. Y.; William H. Breunig, Cincinnati, Ohio; Ames Brown, New York, N. Y.

Frank P. Campbell, Waukegan, Ill.; Carl F. Carlstrom, Worcester, Mass.; W. A. Carmichael, New Haven, Conn.; Leo A. Carten, Washington, D. C.; F. E. Carter, Newark, N. J.; Grant C. Caywood, Omaha, Nebr.; Donald Charlton, Wyomissing, Pa.; Judson I. Cohen, New York, N. Y.; John H. Collier, Providence, R. I.; Ray T. Congleton, Cincinnati, Ohio; Lammot du Pont Copeland, Wilmington, Del.; H. D. Coy, Newark, N. J.; Ernest S. Craig, Providence, R. I.; W. W. Cromley, Washington, D. C.; John H. Crones, Chicago, Ill.; Reuben Upton Darby, II, Woodlawn, Md.; J. B. Decker, Elkton, Md.; Weber deVore, New York, N. Y.

Charles Engelhard, Newark, N. J.; Charles W. Engelhard, Newark, N. J.; William F. Errig, Philadelphia, Pa.; Melvin J. Evans, Chicago, Ill.; Walter Evensen, Chicago, Ill.; Walter J. Ewbank, Washington, D. C.; E. G. Fahlman, Cleveland, Ohio; C. C. Felton, New York, N. Y.; Donald M. Feurt, San Francisco, Calif.; C. S. Finegan, Shreveport, La.; John M. Fisher, Washington, D. C.; Edward T. Foster, Omaha, Nebr.; Julius F. Funk, New York, N. Y.

Wm. F. Gallagher, Springfield, Mass.; Perry D. Gasnier, Detroit, Mich.; F. H. Geisler, Canton, Ohio; James E. Gleason, Rochester, N. Y.; Alvin C. Goddard, New York, N. Y.; Carl Gotthardt, Bridgeport, Conn.; Richard A. Grinnell, Berkeley, Calif.; Willard L. Groene, Cincinnati, Ohio; William R. Hainsworth, New York, N. Y.; Bob Hamilton, Racine, Wis.; George L. Harberger, Pottstown, Pa.; Earl Haskins, Canton, Ohio; Adam P. Heist, West Reading, Pa.; William H. Hendrick, Quantico, Va.; Arthur A. Hess, Eastford, Conn.; Ross M. Heyl, Oakmont, Pa.; R. DeW. Higgins, Sewickley, Pa.; T. Kirk Hill, Los Angeles, Calif.; Samuel W. Himel, Allentown, Pa.; H. D. Hinshaw, Fort Wayne, Ind.; W. H. Hitchcock, New York, N. Y.; James H. Holan, Jr., Lakewood, Ohio; J. L. Homer, Fort Sheridan, Ill.; William R. Huber, Langley Field, Va.; Homer D. Huey, Baltimore, Md.; S. Foster Hunt, Providence, R. I.

George W. Jackman, Waterbury, Conn.; Joseph C. Jefferds, Boston, Mass.; C. A. Johnstone, Seattle, Wash.; George S. Jones, Jr., Evansville, Ind.; Malcolm F. Judkins, McKeesport, Pa.; Clifford F. Kaiser, Glen Head, N. Y.; Charles H. Kanavel, Arlington, Va.; Charles F. Kemper, Harbeson, Del.; J. M. Kennedy, Rome, N. Y.; Robert L. Kenngott, New York, N. Y.; Wm. R. Kepler, Wauwatosa, Wis.; John C. Keplinger, Canton, Ohio; J. M. Kerr, Detroit, Mich.; Leo A. Kiley, Buffalo, N. Y.; Harry Klausmann, Newark, N. J.; Karl Kopplin, St. Louis County, Mo.; M. C. Kuepfer, Canton, Ohio; R. E. Laffler, St. Louis, Mo.; Robert Lawson, Chicago, Ill.; G. D. Linke, Bethlehem, Pa.

Roscoe I. Markey, East Orange, N. J.; J. Harry Marshall, Providence, R. I.; James W. Martin, New York, N. Y.; H. R. Matheny, Detroit, Mich.; William M. McBride, Hartford, Conn.; Forrest A. McCall, Rock Island, Ill.; Gerard E. McHugh, Winthrop, Mass.; Robert J. Meier, Boston, Mass.; Alfred W. Minuse, Mount Vernon, N. Y.; W. F. Mittendorf, Newark, N. J.; Holbrook Mulford, Chicago, Ill.; R. Lindley Murray, Providence, R. I.; Daniel D. M. Musgrave, Washington, D. C.; Glenn F. Mustee, Holden, Wash.; John S. Myers, Rochester, N. Y.; Andrew H. Neubauer, Los Angeles, Calif.; Paul C. Nicholson, Providence, R. I.; Donald C. Noakes, New York, N. Y.; William P. Pahls, Los Angeles, Calif.; Zelmer W. Pigue, Lexington, Ky.; Bernard E. Pollak, New York, N. Y.; Wallace L. Pond, Providence, R. I.

Fred C. Raab, Beaver, Pa.; E. L. Reller, Kirkwood, Mo.; Ira S. Ripley, Providence, R. I.; George L. Roach, Evansville, Ind.; Ralph G. Rogers, Evansville, Ind.; V. P. Rumely, Chicago, Ill.; Louis Ruthenburg, Evansville, Ind.; James Fleet Ryland, Richmond, Va.; A. E. Saunders, Providence, R. I.; Herbert J.

Schaumburg, Detroit, Mich.; R. Schnakenburg, Evansville, Ind.; K. Schumpelt, Newark, N. J.; R. G. Scott, New Bedford, Mass.; Lloyd F. Scudder, New York, N. Y.; F. E. Sellman, New York, N. Y.; Francis F. Shipton, Sturges, S. Dak.; Frederick W. Sinram, Cleveland, Ohio; L. A. Skinner, Atlanta, Ga.; Harold S. Smith, Lisle, N. Y.; Maxwell Y. Snow, Milwaukee, Wis.; Lyman B. Sperry, Grand Rapids, Mich.; W. L. Stancliffe, New York, N. Y.; J. E. Stapleton, Fayette, Mo.; William H. Sublette, Baldwin Park, Calif.; Sulpen Sully, El Paso, Tex.

Alden P. Taber, Langley Field, Va.; John G. Tappert, Philadelphia, Pa.; R. S. Taylor, Evansville, Ind.; C. W. Thomas, Detroit, Mich.; G. W. Thomas, Allentown, Pa.; Wm. J. Timberman, Jr., Ridgewood, N. J.; N. I. Townsend, Evansville, Ind.; Richard S. Turner, Atlanta, Ga.; Edwin R. Tuttle, Brookline, Mass.

H. S. Ullmann, Chicago, Ill.; F. S. Van Valkenburg, Waterbury, Conn.; James F. Van Valkenburg, Collingdale, Pa.; Robert N. Voigt, Gary, Ind.; E. Dwight Warner, Springfield, Mass.; C. P. Weekes, Massillon, Ohio; Brinton Welser, Milwaukee, Wis.; Harold Whitehead, Newark, N. J.; L. A. Wiggins, Rome, N. Y.; David F. Wilber, Oneonta, N. Y.; Alvin M. Williams, Newark, N. J.; Robert P. Wilson, Fort Benning, Ga.; William H. Wilson, East Orange, N. J.; Frank H. Winter, Indio, Calif.; Lambert J. Wischerath, Buffalo, N. Y.; Karl M. Wise, South Bend, Ind; Howard F. Woodfin, Rutland, Vt.; F. Zimmermann, Newark, N. J.

NECROLOGY

SAMUEL MATTHEW VAUCLAIN, chairman of the board of the Baldwin Locomotive Works and an outstanding figure in the mobilization of American industry in the early stages of the World War, died at Philadelphia, Pa., on February 4th. He was a charter member of the Army Ordnance Association whose loyalty to the national defense continued unabated since 1918.

An officer and director of many business and industrial organizations, Mr. Vauclain had been associated with the Baldwin Locomotive Works since 1883. He became vice-president of that organization in 1914, president in 1919, and chairman of the board in 1929.

First as chairman of the Locomotive and War Committee of the Council of National Defense and later as chairman of the Special Advisory Committee on Plants and Munitions of the War Industries Board, Mr. Vauclain rendered outstanding service in the mobilization of America's industrial power for defense. His work in this regard was particularly close to the Ordnance Department of the Army.

For his war service to the United States, Mr. Vauclain was awarded the Distinguished Service Medal in 1919. He was also the recipient of Il Cancelliere Order of the Crown of Italy, Order of Polonia Restituta, and Chevalier of the Legion of Honor.

Mr. Vauclain was a familiar and admired figure at meetings of the Army Ordnance Association, particularly at the Aberdeen Proving Ground. He will be missed by all his associates as an exemplar of a type of virile American administrator who in time of emergency possesses in high degree the rare quality of getting things done.

NOTICE has been received of the death of the following members of the Association: H. G. Dalton, Cleveland, Ohio; John J. Grimes, Birmingham, Ala.; P. P. Kearney, Ardmore, Okla.; Fred K. Knowlton, Rochester, N. Y.; Henry W. Linneen, Manhasset, L. I., N. Y.; William L. MacRae, Syracuse, N. Y.; Philip Rhinelander, Long Beach, N. Y.; Victor Showalter, Elgin, Ill. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

Professional Digest

The following abstracts are based on current periodicals and events and aim to present a wide range of facts and opinions regarding recent developments of professional military interest. Quotation marks are omitted but sources are indicated.

CONTINUING EXHAUSTIVE TESTS OF THE Garand semiautomatic rifle, caliber .30 M1, primarily concerned with types of accessories and lubrication for the rifle under various conditions of service, the Infantry Board at Fort Benning, Ga., recently fired 40,000 rounds of ammunition from stock rifles. Every effort was made to duplicate the worst conditions likely to be encountered in active campaign, according to the *Army and Navy Register*.

Tests included check firing with special high-power armor-piercing ammunition; firing with ammunition encrusted with mud, sand, and water; firing with ammunition which had been soaked in water and left to corrode in bandoleers for several days. The rifles were fired several hundred rounds a day for four successive days without cleaning or oiling. They were not put out of action. The rifles were sprayed with water and thrown around in the sand and dirt and then fired with only such wiping off as the soldier did with his bare hands. They continued to function, and in not a single one of the tests was a rifle put out of action, nor did any of them appear to have lost accuracy.

Another test consisted of putting each of the rifles, equipped with two different types of front-end assemblies, through the standard bayonet course two hundred times with untrained men. The rifles were test-fired for accuracy before and after, and the results compared. It was found that their accuracy and functioning had not been affected. The rifles functioned as well with the bayonets on as off, so that it has not been necessary to sacrifice ruggedness or usefulness in close combat, in order to gain the increase in fire power the rifle provides.

These and other tests further confirmed the conclusion drawn from previous experience with the new semiautomatic rifle, involving the firing of hundreds of thousands of rounds, that the Garand is the finest shoulder rifle in the world. Contrary to what might be expected, since any automatic weapon is necessarily a more complicated piece of mechanism than a hand-operated one, the mechanical maintenance and repair work necessary to keep it in action is actually less than for the old Springfield; also, while the accuracy of the Springfield for individual shots in slow fire of short duration has never been exceeded with any military weapon, it has been found that when there is considerable firing to be done in a given length of time, as in battle, the average accuracy of such fire is considerably greater with the Garand rifle, due to the fact that the firer's position is not disturbed between shots by any necessity for hand manipulation. The reduction in recoil as compared to the Springfield or other high-power shoulder rifles greatly reduces the drain upon the physical and nervous endurance of the firer. Prolonged firing does not result in the bruised shoulder, cheek, and nose associated with other high-power rifles. The result was strikingly illustrated when an equal number of men of equal training fired over the same course with both the Springfield and the Garand rifle, and the results compared. The group firing the Garand obtained 2.36 times as many hits per man per minute as the group firing the Springfield.

The effect is to increase the fire efficiency of troops armed with this weapon—more accuracy per shot, more shots per minute, and more minutes of effective firing.

Ordnance Field Service

A Novel Training Maneuver for Ordnance Reservists

By Lieut. R. B. Shuman, Ord. Res.

THE job of the Ordnance Department may be divided into two principal tasks: (1) Technical advance and procurement, and (2) Storage, issue and maintenance. The former is the responsibility of the manufacturing branch, the latter of the field service. It would be ridiculous to argue which of the two functions of the Department is the more important, for they are mutually dependent. It seems especially true, however, that in time of peace the Field, or Military, Service, as more purely an Army organization, is less familiar to the industrialist and our citizenry in general than the manufacturing or Industrial Service. The reasons for this are obvious enough. The fact remains, however, that both services are working toward the same end—the increase of the combat efficiency of the Army. Because of this relationship, it is felt that a sketch of some methods employed to advance the training of the Field Service and, especially, assigned civilian components, may be of interest to readers of Army Ordnance.

There are peculiar difficulties encountered in effecting training of civilian components from the Field Service point of view—a point of view important to the great bulk of the Ordnance Reservists in the Seventh and Eighth Corps Areas since they are assigned to Military Service units. A Reserve officer assigned to the Industrial Service of the Department may readily be assigned to an arsenal or, in some instances, may do much to perfect himself in the details of his potential war assignment while on the job in civilian life, as in the case of a superintendent of a machine-tool firm which is working on an educational order.

Repairing Caliber .30 Machine Gun of the 12th Cavalry at Boca Chica Target Range

The assignment of Reserve officers or R.O.T.C. cadets to a light or medium maintenance company of the Regular Army is another matter. Such a company organization is presumed to be a mobile unit, especially in light of the doctrines of our Army which stress aggressive and mobile warfare. The temptation of a technical service, however, is to immobilize itself by the continuous addition of facilities which are most useful at a base in peace time but represent an impossible luxury under war conditions. The reduction of a maintenance unit's encumbrances to the bare minimum lessens the number of trucks necessary and the time and labor involved in setting up shop, thus permitting devotion of the greatest possible time to the actual work of inspection, repair, and field modification. But such a reduction of the impedimenta of the divisional Ordnance company to the basic requirements for performance of the job is likely to be a paper proposition unless the organization engages in field maneuvers which realistically present the problem to officers and men. It can be seen, therefore, that civilian components assigned to Regular Army Ordnance units of this type cannot be expected to gain a sound appreciation of war-time conditions unless they take part in field work under circumstances which present a "reasonable facsimile" of war conditions.

Furthermore, the technical side of the Ordnance organization tends to be emphasized at the expense of the unit's self-maintenance activities while on the post. (Self-maintenance activities referred to include such elemental functions of field operations as the movement of the truck convoy, operation of the mess, loading and unloading of trucks, rapid erection of shelter for equipment and personnel, and the like.)

BEARING in mind the general considerations outlined above, Col. Edward A. Keyes, in charge of civilian components in the Eighth Corps Area, and Col. James K. Crain, corps-area Ordnance officer, decided, in 1938, that the best interests of assigned Reserve officers, R.O.T.C. cadets, and the Regular Ordnance company (medium maintenance) assigned to the 2nd Division at Fort Sam Houston, Tex., would be served by the institution of a 4-week training maneuver by truck convoy through South Texas. It was decided that several Army posts and National Guard units should be covered in the 1,000 miles traveled by the provisional unit established. Annual inspection requirements of the various units visited would be taken care of by joint action of the detail from the 2nd Ordnance Company and the attached civilian components.

The trial was made in the summer of 1938, the Provisional Ordnance Company formed for the occasion being under the command of Maj. G. A. Woody, then post Ordnance officer at Fort Sam Houston and commanding officer of the 2nd Ordnance Company. The results seeming to justify further efforts, a Provisional Ordnance Company was set up for the summer of 1939, composed of forty men of the 2nd Ordnance Company and forty R.O.T.C. cadets. The great majority of the cadets were engineering seniors in their respective universities. The group of cadets was made up mostly from the Ordnance Unit at the University of Oklahoma but also included men from the University of Arkansas, State University of Iowa, North Dakota Agricultural College, Missouri School of Mines, University of Nebraska, and the University of Minnesota.

Four Reserve officers, including one 1st lieutenant, and three 2nd lieutenants, were attached for the 30-day period. The Provisional Company thus instituted was under the command of Capt. W. J. Crowe, Ordnance Department, whose regular assignment is with the Ordnance R.O.T.C. Unit at the University of Oklahoma. The motor convoy was made up at Camp Bullis, Tex., summer training area of the 2nd Division, and left with twenty trucks and a personnel of eighty-five on Monday, June 19, 1939. The R.O.T.C. cadets, having arrived at Camp Bullis on June 4th, had had two weeks of preliminary training to prepare them for the trip.

The service section or shop unit of the Ordnance company included in its mechanical equipment a lathe, a grinder, a milling machine, electric- and gas-welding equipment, and a gasoline-operated generator for the power tools mentioned. The armory

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and artillery sections were provided with their respective complements of tools and parts.

The service section's relatively weighty machines were loaded and unloaded from trucks with a tripod. Without any attempt being made to set a record, it was determined that this section, with its three tents, could be set up in an hour and a half from the time the trucks arrived on the site.

Following is an example of the training routine for the combined force of Regulars and R.O.T.C. cadets, founded on a typical day at Fort Crockett. The detail was for 7:15 A.M., Friday, July 7, 1939, to inspect and repair Ordnance matériel of Battery E, 69th Coast Artillery, at Fort Crockett, Tex.

INSPECTING RIFLES OF THE 12TH CAVALRY AT BOCA CHICA TARGET RANGE

Headquarters and Supply Section.—Orderly Tent: 1st sergeant, company clerk; cadet 1st sergeant, cadet supply sergeant, cadet company clerk.

Service Section.—Service-section sergeant and three cadets to assist in machine shop; Shop office: shop corporal, cadet shop clerk; Optical: one private, first class, and one cadet to assist in inspection and repair of fire-control instruments.

Armory Section.—Armory corporal; one private and five cadets, to inspect, repair, and record data for rifles; two privates and five cadets, to inspect, repair, and record data for pistols; three privates and five cadets, to inspect, repair, and record data for machine guns.

Artillery Section.—One private, first class, and five cadets, to inspect, repair, and record data for artillery.

Automotive Section.—Two privates, first class, and three cadets, to inspect and repair Ordnance motor trucks.

Miscellaneous Accessories and Ammunition.—One sergeant, one private, first class, and five cadets, to inspect, repair, and record data for ammunition, leather equipment, and miscellaneous supplies.

Each cadet had a turn at every assignment in the activities of the company, both technical and administrative. War Department requirements as to subjects covered by R.O.T.C. cadets during their summer encampment were complied with fully. These requirements include interior guard duty, defense against chemicals, close-order drill, calisthenics, etc.

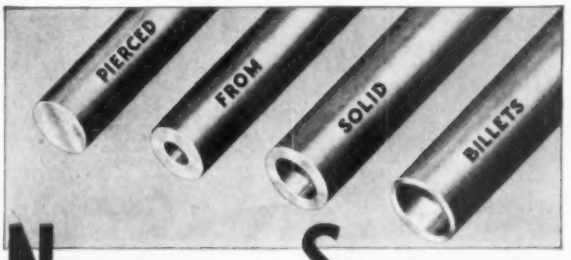
The following table shows the major items of Ordnance matériel inspected. Approximately ninety per cent of the items were repaired. The stations visited also are listed.

Item	Beeville	Fort Brown	Fort Crockett	San Benito	Total
Altimeter, M1920		3			3
Car, scout, T7		4			4
Cart, hand, M4				4	4
Circle, aiming, M1916		1		1	2
Clinometer, MG., M1917		10	8	8	26
Compass, prismatic, M1917			1		1
Director, M1A1		1			1
Eyeglass, amber-colored			20		20
Finder, range, 80-cm. base, M1917		1			1
Finder, range, 1-meter base, M1916			3		3
Finder, range, 2-meter base, Stero Zeiss			1		1
Glass, field, type EE, with cases	3	72	22	3	100
Gun, field, 3-inch, saluting, M1902		1	2		3
Gun, machine, cal. .30, M1919A2		26			26
Gun, machine, cal. .30, M1917		8	16	4	28
Gun, machine, cal. .50, M2		11	16		27
Gun, submachine, cal. .45, Thompson, M1928A1		4			4
Gun, machine, cal. .22, U.S., M1		4		2	6
Gun, 37-mm., M1916	3	2			5
Gun, 3-inch, antiaircraft, M3			4		4
Howitzer, 155-mm., with carriages	2				2
Instrument, angle of site, M1917		3		2	5
Instrument, azimuth, A.A., B.C., T1, M1918			1		1
Instrument, observation, antiaircraft, B.C., M1			2		2
Pistol, automatic, cal. .45, M1911	70	540	231	65	906
Projector, signal, ground, M1, with support		3			3
Recorder, time-interval		14	32		46
Revolver, cal. .45, M1917		32			32
Rifle, automatic, cal. .30, M1918	6		23		29
Rifle, U.S., cal. .30, M1903		272	447	3	722
Rifle, U.S., cal. .30, M1		9		5	14
Rifle, U.S., cal. .22, all models		32	17	1	50
Shotgun, 12-gauge, Winchester riot type		17	15	1	33
Sight, telescopic, T3		8			8
Telescope, M3		5			5
Tractor, medium, M1, Diesel			2		2
Tractor, medium, M1, gasoline			1		1
Watch, wrist, 7-jewel		20	14		34

In addition to major items listed above, all accessories were inspected, repaired, or exchanged, if unserviceable.

The Provisional Ordnance Company arrived in Camp Bullis from Galveston on the afternoon of June 13th, having covered 1,033 convoy miles in five days on the road. The itinerary was Camp Bullis, San Antonio, Beeville, San Benito and Brownsville, Victoria, Galveston, San Antonio, and finally Camp Bullis again. No highway accidents occurred either to personnel or trucks.

In conclusion, the results of this type of field instruction seem to justify the attempt to simulate war-time conditions as closely as possible, not only, it may be remarked, for the benefit of the Reserve officers and cadets attached to the Provisional Ordnance Company, but of the Regulars as well.



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Ordnance in Review

RECENT DEVELOPMENTS IN SPORTING ARMS, PART III

BY LIEUT. COL. CALVIN GODDARD, ORD. RES.

IF John Mahlon Marlin were able to revisit today the plant he founded in 1870, the chances are that he scarcely would recognize his industrial offspring. For many and significant have been the changes wrought since his time. A pioneer in the sporting-arms field and flourishing at a period when the diversity of types, calibers, and models was almost infinite, he tried his hand equally at rifles, pistols, and revolvers, producing in each field specimens which embodied sound and serviceable features. Two years before his death he perfected his first shotgun—a pump-action repeater (1898).

But his greatest reputation derives, and rightly so, from the rifles which have borne his name. The famous "solid top and side ejection" of the Marlin lever-action repeating rifle represented an advance over other similar mechanisms, the superior qualities of which were generally acknowledged. And although the firm he founded has experienced, in the years which have passed, perhaps more than its meed of vicissitudes, it has continued, despite numerous ventures into new and uncharted fields, to adhere to one splendid tradition—the manufacture of the rifle with which the history of frontier America is inextricably bound—the good old tube-magazine, lever-action repeater!

THE MARLIN .410 "OVER-UNDER" SHOTGUN

Some years back the firm of Marlin surprised the scattergun sportsmen by producing a .410-bore shotgun (for the 2½-inch shell) which embodied the same mechanism. This came, unfortunately, at a period when the "pump" or "trombone-action" shotgun had gained such popularity that it was difficult to find a market for one of the lever type. And the subsequent perfection of the *3-inch* .410 shell (which the action of this model was too short to handle) and its instant popular acclaim, wrote *finis* to the tale.

Thenceforward Marlin's activities in the smoothbore field were relatively quiescent until the release, in 1936, of a hammerless "over-and-under" shotgun in 12 gauge. So well was this received that 16 and 20 gauges were added in 1938 and a .410-gauge in 1939. Because of the increasing trend toward smaller bores and toward the "over-and-under" type of shotgun action as well, it may not be amiss to analyze a specimen of Marlin's offering in this size for the readers of ARMY ORDNANCE.

The example in my possession tips the scales at 5¾ pounds—a reasonable weight for such a piece. Its over-all length is 45⅝ inches. The balance is at the joint—approximately 5 inches ahead of the forward trigger. The pull required to release that member

(which fires the shell in the *lower* barrel) is 6¾ pounds by spring balance (Parker)—7 pounds by dead weight. That for the rear trigger is 8½ pounds by spring balance—9½ pounds by dead weight—figures distinctly toward the "high" section of the scale, but which the company assures me are (in respect of the rear trigger at least) not representative, its practice being to require *both* triggers to pull off on a dead weight of not more than 7 pounds.

THE mechanism, as indicated, is hammerless. There is a conventional safety slide on the upper tang which is automatically set when the gun is broken open. The trigger guard, unlike that of the usual "side-by-side" double gun, is a composite one, with part of the cocking mechanism in the forward element. The blued finish is of a handsome, velvet-black tone, and on both sides of the receiver appear engravings of a setter dog in action.

The woodwork is nicely grained and exhibits an attractive dull finish. The stock is shaped to a pistol grip and ends in a checked buttplate of hard rubber. Inletting of metal parts is tight and neat, save at the rear ends of the tangs (especially the lower) where a minute bit of space may be noted on close scrutiny.

The drop at comb measures 1 5/8 inches; at heel, 2 5/16 inches—hardly sufficient for a tall man with long neck and arms but doubtless correct for the majority of shooters. The stock length (14 3/16 inches) coincides with conventional standards.

The forearm, while by no means skimpy, is at the same time far from the beavertail type which has become so popular in recent years. Neither it nor the grip is checked in the standard model but checkering may be had at a modest additional outlay.

The action is tight as a drum—perhaps a bit too tight—but doubtless will smooth out with use. Chambering is for the 3-inch shell, and the top barrel is matted to reduce glare. Both barrels, which are 26 inches long, are bored full choke. The single (front) sight is the conventional brass bead. A satisfactory take-down mechanism is incorporated. One noticeable feature is the swell of the top of the barrel at the breech, suggesting that additional metal has been left there for increased strength. The result is not displeasing to the eye, but rather the contrary. But to this rifle-minded reviewer, the "hump" remains a bit overprominent.

Marlin is to be congratulated upon having pioneered, unless my memory fails me, the first all-American-made "over-and-under" hammerless shotgun in the moderate-price brackets. And I have no doubt that the shade of John Mahlon Marlin smiles down in satisfaction upon this handsome product of the firm that bears his name. (*To be continued.*)

Communications

"THE DEFENCE OF BRITAIN"

THE EDITOR:

It has been pointed out to me that a passage in my article "A Defensive Military Theory" on Liddell Hart's book "The Defence of Britain" in your January-February issue (Vol. XX, No. 118, p. 216) can be taken as reflecting upon the present British war effort.

This was far from my intention. I was discussing Liddell Hart's thesis that England might better serve the common Franco-British cause by not raising a mass army so that she might be free to develop a maximum naval and air effort. Whether or not one shares this belief, it is at least arguable. Since I did not mean to imply or assume that the present British war effort suffered from slackness, and since that misunderstanding has arisen, I am glad to correct it in this letter.

Oyster Bay, L. I., N. Y. HOFFMAN NICKERSON.

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Book Reviews

WARFARE: THE RELATION OF WAR TO SOCIETY. By Ludwig Renn. Translated by Edward Fitzgerald. New York: The Oxford University Press. $2.50.

THE author's gallant attempt to cram into one small volume the history, theory, and evolution of warfare, plus the tactical problems of modern military science, plus the many-sided relationship of war to politics, economy, and sociology, could scarcely have resulted in a really satisfactory work. Nevertheless, by dividing the volume into three parts and subdividing each part into numerous sections, and by some really clever and at times brilliant writing, he has turned out a book which might have had great value for the average reader, if its worth were not more than overbalanced by the gyrations of its decidedly "leftist" author.

Starting with "Warfare in General," Renn gives us some shrewd observations and conclusions on the aims, the economy, and the probable profit or loss of various types of wars. Proceeding to "The Practical Conduct of Warfare," he essays to outline the strategy and tactics of land and naval conflict in 170 pages. The author here displays a quite comprehensive knowledge of tactics, particularly minor tactics, and a good historical background. This entire part would have been much improved had he given, in the short space available, only the high lights—leaving out many less important though interesting details.

This shorter method was used in writing the chapter devoted to "Naval Tactics and Strategy," and it results in what is possibly the clearest picture in the volume. The section on air bombing, in which the author demonstrates from personal experience the comparative ineffectiveness of this arm against seasoned troops and even fairly well defended objectives, is splendid; his valuation of tank warfare, pointing out its many weaknesses but showing the value of the tank when used as mobile armored artillery, is perhaps the best this reviewer has ever seen.

In Part III, "War Propaganda and Military Training," his work slacks off badly, for despite some clever comments and deductions, the author's left-wing viewpoint is given free rein, and his statements descend to a childish level. It is this extreme leftist viewpoint that must swing any fair appraisal of this book far to the debit side. It not only colors the work as a whole and confuses by the constant use of such revolutionary jargon as "fascist," "loyalist," "authoritarian," and "democratic," but it twists whole sections by the use of the too-sweeping statement and the specious half-truth, so well loved and so freely used by the "fellow traveler." It is in his treatment of the Spanish Civil War (in which he served as an officer with the Reds) that the author plumbs the very depths of nonsense and of spleen. Objective truth seems to go by the board as such thoroughly discredited fables as "the massacre in the bull ring of Badajoz" are given as sober fact. But the culminating height of hysterical absurdity is reached as the author speaks of "the conquest of Spain by Germany." Indeed, in so far as the book's treatment of the Spanish Civil War is concerned, it seems to be little more than a rehash of the *Daily Worker*, *L'Humanité*, and journals of that color.

The second great weakness of the author is his seeming great love and admiration for the Soviet Union and for internationalism. This befogs all comment where Soviet Russia is concerned. How we should enjoy Renn's comments, if any, on the Nazi-Soviet pact, concluded so shortly after this book was written! Regarding his evaluation of the present Russian Army,

tiny Finland has answered—"the mighty fist of the proletariat" has been shown conclusively to be resistible. Surely, after these judgments, Renn's conclusions must be taken with so much salt that they become emetic. We could wish that the many clever observations and brilliant passages were embodied in a more rational and less propaganda-ridden work. F. W. F. G.

HANDBOOK OF THE WAR. By John C. de Wilde, David H. Popper, and Eunice Clark. Boston: Houghton Mifflin Company. $2.

WHATEVER forces can be evaluated to determine the relative strength of the various actual and potential belligerents in the present European war have been considered in this extraordinarily successful manual. It is by far the most useful and accurate handbook yet made available to explain modern history in the making.

One very important fact that strikes the reader immediately is the inclusion in this book of all the elements that go into the war-making resources and powers of a country. In other words, readers of ARMY ORDNANCE always must have been disappointed, in examining earlier books of this kind, by the constant failure to include any comment on the industrial resources of the warring nations. Factories, raw materials, labor, transportation, apparently were of no moment in estimating the war potential of a belligerent country. Economic pressure and the means of obtaining it evidently were considered to be of minor importance compared with the force exerted by armies in the field. The highly important utilization of psychological pressure by propaganda usually was overlooked in these studies.

This book has been particularly successful in tabulating the relative strength of the nations, not only in the equipment of armies and navies, but in the national resources in industries and mines and shipping.

It is not only a readable book, well written, objective, and impartial, but with its excellent charts and maps it will be continuously in demand in following the developments of the war. D. A.

HISTORICAL REGISTER OF VIRGINIANS IN THE REVOLUTION. By John H. Gevathmey. Richmond: The Dietz Press. $15.

THIS is a beautifully prepared roster of nearly nine hundred pages of the soldiers, sailors, and marines who served in the American Revolution (1775-1783). The author has performed a great service to historians, genealogists, and patriotic organizations. In an introduction to the book, Dr. H. J. Eckenrode, director of the Virginia Division of History and Archæology, writes, "For persons interested in tracing the decendants of Virginia soldiers and to historians desiring to know Virginia's contribution to the American cause in the Revolution, this volume is invaluable." O. E. D.

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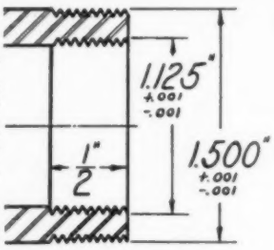

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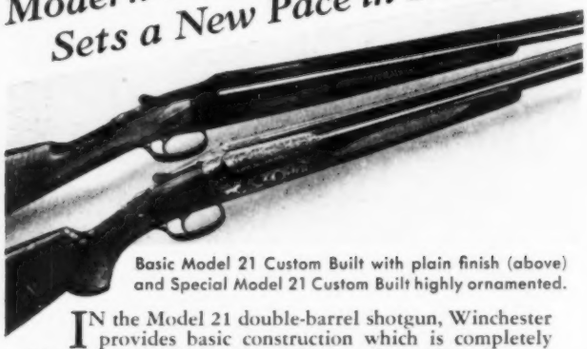

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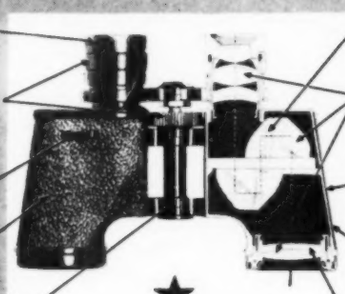
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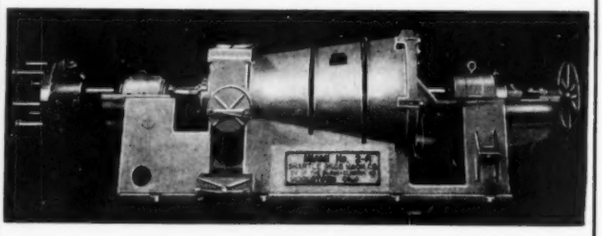

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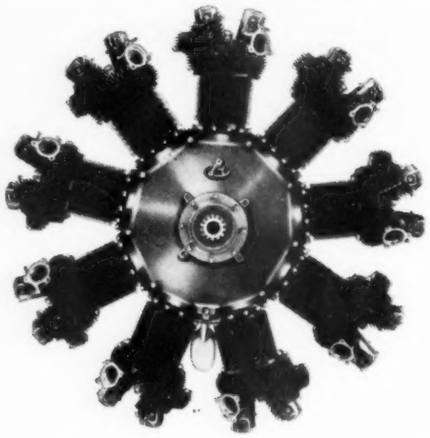

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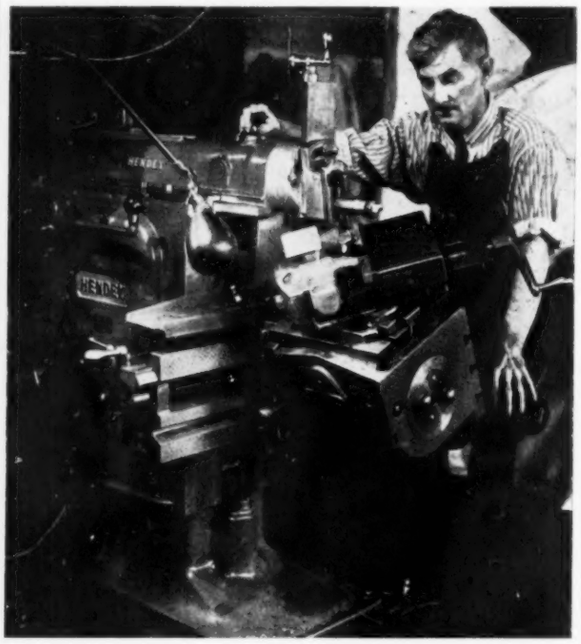

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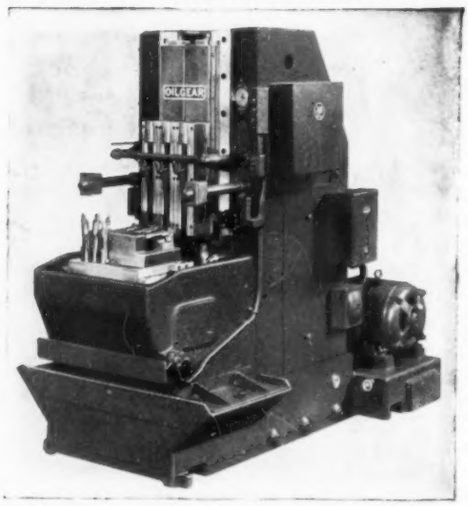

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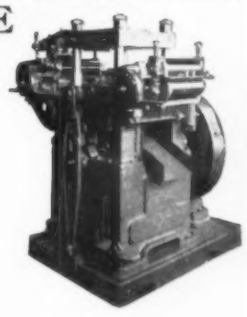

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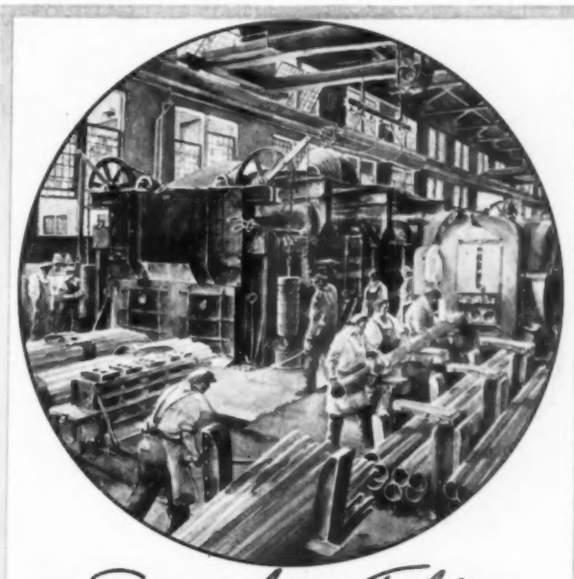

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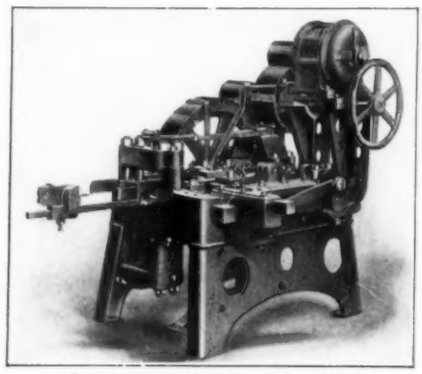

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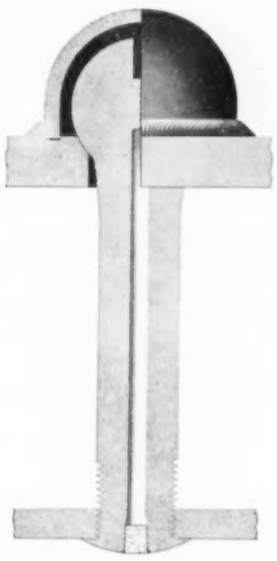

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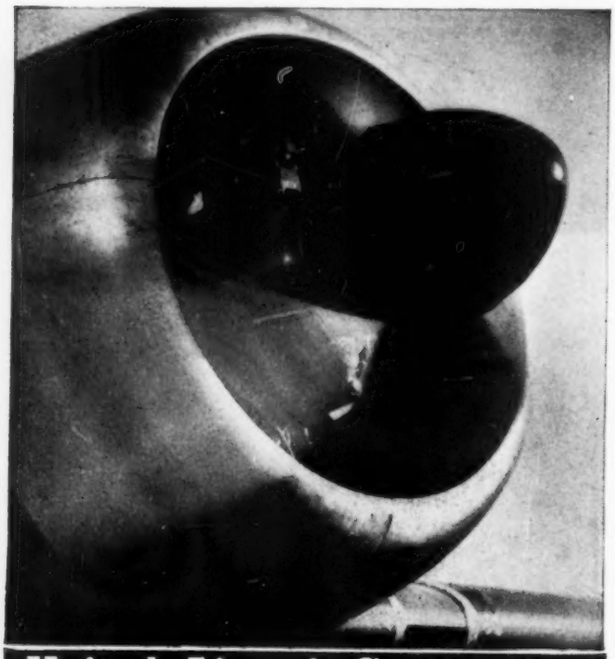

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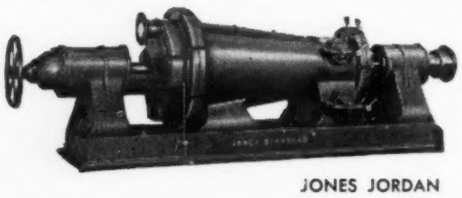

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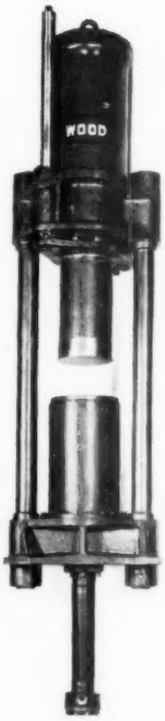

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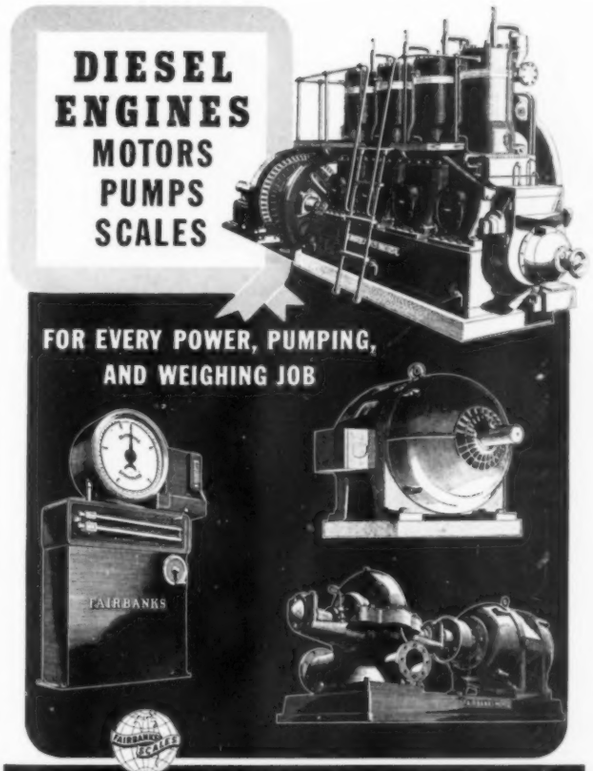

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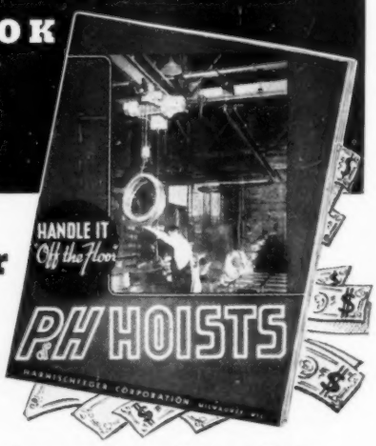

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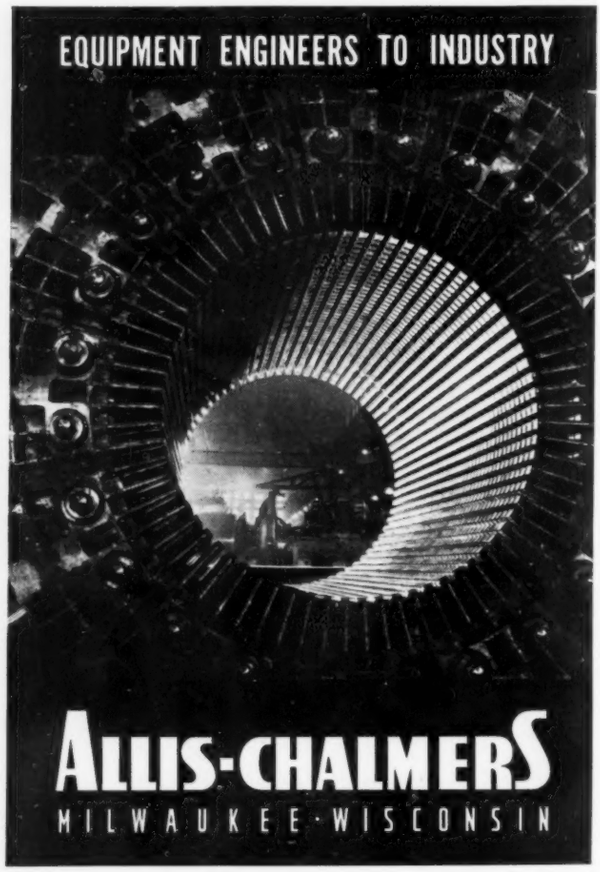
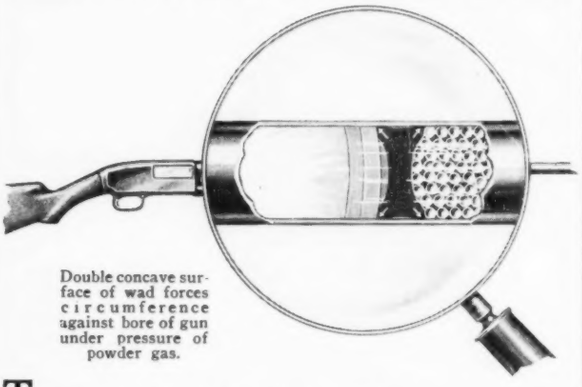


Western SEAL-TITE Wad
Insures Uniform Performance



Double concave surface of wad forces circumference against bore of gun under pressure of powder gas.

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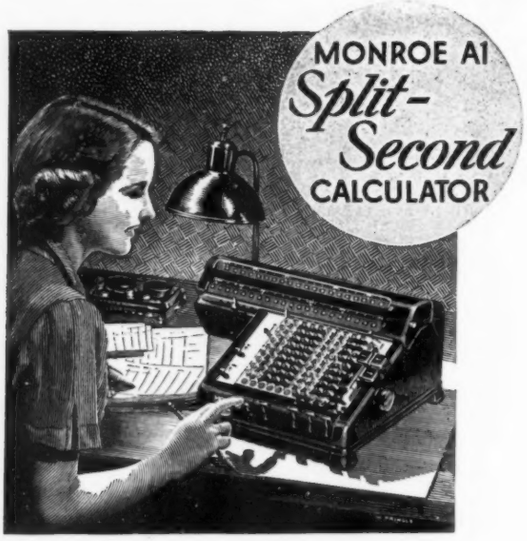
UNIFORM SHOT SHELLS



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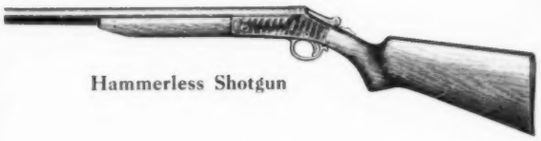

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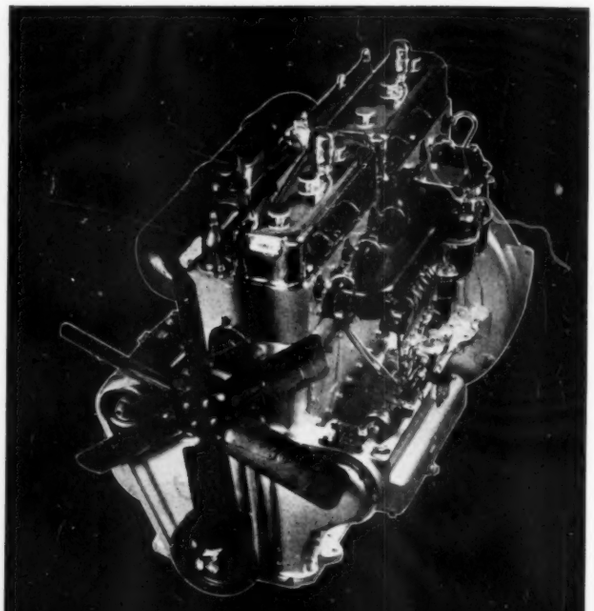

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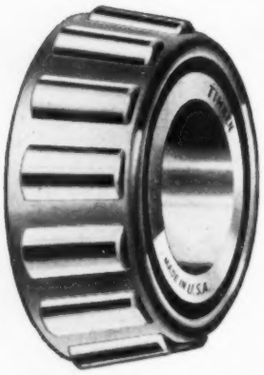

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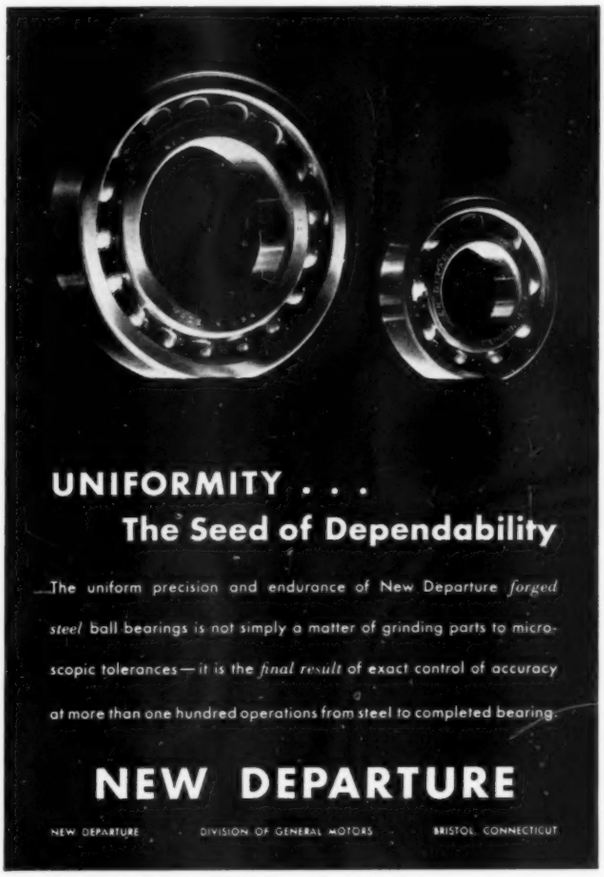

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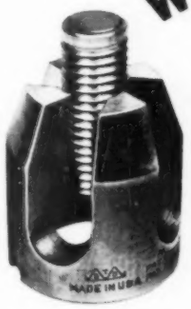

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For Army and Navy

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BENDIX AVIATION CORPORATION

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Through their advertisements in ARMY ORDNANCE, *the manufacturers listed below give testimony of the value they place upon the quality of its circulation and of their approval of the purposes for which this journal stands. One hundred and six companies are represented as advertisers in this issue.* ARMY ORDNANCE *appreciates their support and, in turn, recommends their products to its readers. In addressing communications to advertisers it will be appropriate to mention this journal—the reader's needs, the advertisers' products and the value of* ARMY ORDNANCE *will be enhanced thereby. The Army Ordnance Association reserves the right to reject advertisements inconsistent with its publication standards.*

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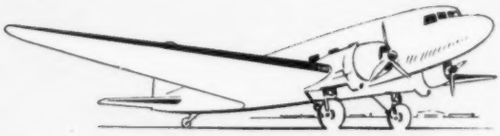
"America Steps Ahead with these newest Elgins" says Donald Douglas



World's most noted aircraft designer, builder of first globe-girdling planes and of "DC" transports, Mr. Douglas appraises the new ELGINS *with keen technical eyes.*

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Lord Elgin · Lady Elgin

21 Jewels **19 Jewels**

They enrich a timepiece tradition that has thrived in America for generations

You who cherish accuracy should note this fact: only Lord and Lady Elgins offer you such complete assurance of timekeeping excellence. Each of these finely adjusted watches must prove its ability *right in a great astronomical observatory.* Only after exhaustive tests is each awarded its own individual Observatory Certificate.

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